US EPA RECORDS CENTER REGION 5
466875

U.S. EPA REGION V

IN RE: Gary Development Company
Docket No. RCRA-V-W-86-R-45

COMPLAINANT'S PRETRIAL EXCHANGE

FOLDER ONE Exhibits 1-18

JUDGE GREENE'S CASE FILE

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U.S. ENVIRONMENTAL
PROTECTION AGENCY

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION V

IN THE MATTER OF:	)	
	)	
GARY DEVELOPMENT COMPANY, INC.	)	Docket No. RCRA V-W-86-R-45
GARY, INDIANA	)	
	)	
EPA I.D. No. IND 077 005 916	)	Judge Greene
	)	

COMPLAINANT'S PRETRIAL EXCHANGE

NOW COMES THE COMPLAINANT, the Director of the Waste Management Division of the United States Environmental Protection Agency, Region V, by and through his attorney, to submit the following information as a pretrial exchange pursuant to Administrative Law Judge J.F. Greene's Order of December 9, 1986 in this matter.

I. Place of Hearing

The Complainant desires to hold the hearing in Chicago, Illinois, and offers to arrange for a hearing room in the Federal Buildings.

II. List of Witnesses

A. Martin Hamper, Geologist
U.S. Environmental Protection Agency
Region V (5HS-13)
230 South Dearborn St.
Chicago, Illinois 60604

Nature of Testimony: Explanation of RCRA permit application requirements and attainment of interim status as they pertain to Respondent. Demonstration of facts necessary to substantiate that Respondent did not attain interim status by failing to file a hazardous waste notification as required by Section 3010 of RCRA and that Respondent's Part A application did not include hazardous waste number D008 (lead). Demonstration of facts necessary to substantiate that Respondent has not submitted Part B permit application or certification of compliance with applicable RCRA groundwater monitoring and financial requirements as required by Section 3005 of RCRA and that Respondent must therefore close its facility.

B. Jonathan Cooper
Hydrologist
U.S. Environmental Protection Agency
Region V (5HE-12)
230 South Dearborn St.
Chicago, Illinois 60604

Nature of Testimony: Explanation of applicable Indiana hazardous waste management requirements set forth at Title 320 Ind. Adm. Code Article 4.1. Showing of facts necessary to establish that Respondent violated almost all applicable regulatory requirements for hazardous waste facilities and that the Indiana State Board of Health has made reasonable efforts to obtain compliance. Establishment of reasonableness and necessity of actions ordered by U.S. EPA of Respondent in light of Indiana hazardous waste management and interim status requirements.

C. Ted Warner
Inspector
Indiana Department of Environmental Management
150 S. Meridian Street
Indianapolis, Indiana 46225

Nature of Testimony: Explanation of applicable Indiana Hazardous waste management requirements set forth at Title 320 Ind. Adm. Code Article 4.1. Showing of facts necessary to establish that Respondent violated almost all applicable regulatory requirements for hazardous waste facilities and the IDEM has made reasonable efforts to obtain compliance. Establishment of serious potential for harm posed by such noncompliance. Establishment of reasonableness and necessity of actions ordered by U.S. EPA of Respondent in light of Indiana hazardous waste management and interim status requirements.

D. Undetermined Toxicologist and/or Hydrogeologist

Nature of Testimony: Demonstration of potential harm posed by Respondent's noncompliance with hazardous waste management standards, including Respondent's noncompliance with groundwater monitoring requirements.

III. List of Exhibits

At hearing Complainant intends to offer the following exhibits into evidence:

Number	Date	Description
1	November 18, 1980	Part A permit application
2	June 18, 1982	EPA letter advising GDC that facility does not have interim status
3	February 8, 1984	EPA letter to GDC saying F005 not properly treated and facility must close
4	October 12, 1984	Harding Lawson Associates report regarding insufficient groundwater monitoring at GDC
5	March 12, 1985	EPA letter to GDC informing about HSWA groundwater monitoring requirements
6	March 18, 1985	EPA Part B call-in to GDC
7	March 29, 1985	ISBH letter to GDC regarding financial assurance requirements
8	May 1, 1985	ISBH letter to GDC demanding Compliance
9	June 17, 1985	ISBH inspection report
10	July 16, 1985	ISBH letter to EPA regarding 6/17/85 inspection and Part B call-in
11	July 29, 1985	ISBH office memorandum regarding 6/17/85 inspection
12	October 22, 1985	ISBH enforcement referral to EPA
13	February 6, 1986	ISBH office memorandum regarding deficient clay liner and leachate leaks
14	March 3, 1986	EPA notification of Complaint to ISBH
15	April 18, 1986	ISBH office memorandum regarding noncompliance with RCRA groundwater monitoring requirements

Number	Date	Description
16	October 27, 1986	EPA letter to GDC informing of verification of hazardous waste and demanding compliance with Complaint
17	January 14, 1987	IDEM letter to EPA regarding 8/22/86 inspection
18	May 2, 1980	EPA Background Document for EPA Toxicity Characteristic (D008)
19	July 7, 1980	EPA Background Document for 40 C.F.R. §§ 261.31 and 261.32 Listing of Hazardous Wastes (K087, F005)
20	October 29, 1986	LTV Steel Response to Information Request regarding Jones and Laughlin's shipments of K087 to GDC from 11/80 to 3/82
21	December 1, 1981	EPA HQ letter to Jones and Laughlin regarding preliminary delisting of F006 only
22	October 24, 1986	American Chemical Service, Inc. Response to Information Request regarding shipments of F005 between 12/5/80 and 11/16/81
23	September 29, 1986	USS Lead Response to Information Request regarding shipment of battery chips, reverb slag and calcuim sulfate sludge (D008) from 11/20/80 to 1/21/83
24	August 12, 1982	USS Lead letter to EPA regarding lead waste and shipping off site
25	September 26, 1983	USS Lead analyses of battery chips and calcuim sulfate sludge disclosing high lead content
26	February 22, 1982	Generator Annual Report for Jones and Laughlin, 1981, showing 3,203,500 pounds of K087 shipped to GDC
27	February 17, 1982	Generator Annual Report for American Chemical Services, 1981, showing 396 tons of F005 shipped to GDC

Number	Date	Description
28	June 10, 1982	EPA letter to ISBH regarding no hazardous waste notification from GDC

IV. Reservation of Rights

Complainant reserves its right to supplement this submittal with additional evidence should such become available.

Respectfully submitted,

Marc M. Radell

Marc M. Radell
Assistant Regional Counsel
U.S. EPA, Region V
230 S. Dearborn Street
Chicago, Illinois 60604

Dated this 13th day of February, 1987.

UNITED STATE ENVIRONMENTAL PROTECTION AGENCY
REGION V

Re: Gary Development Company
Docket No. RCRA-V-W-86-R-45

CERTIFICATE OF SERVICE

I hereby certify that on February 13, 1987, the original Complainant's Pretrial Exchange in this matter was hand carried to the Regional Hearing Clerk and that true and accurate copies were served as follows:

By pouch mail to: Honorable J.F. Greene
Office of Administrative Law Judges
(A-110)

By certified mail to: Waren D. Krebs, Esq.
Parr, Richey, Obremskey & Morton
121 Monument Circle
Suite 500
Indianapolis, Indiana 46204

By: Marc M. Radell
Marc M. Radell
Assistant Regional Counsel

Please print or type in the unshaded areas only
(Fill-in areas are spaced for elite type, i.e., 12 characters/inch).

Form Approved OMB No. 158-S80004

448

FORM 3 RCRA

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY

HAZARDOUS WASTE PERMIT APPLICATION

Consolidated Permits Program

(This information is required under Section 3005 of RCRA.)

I. EPA I.D. NUMBER: F I N D 0 7 7 0 0 5 9 1 6

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (yr., mo., & day)

"Complainant's Exhibit No. 1"

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below *(mark one box only)* to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA I.D. Number, or if this is a revised application, enter your facility's EPA I.D. Number in Item I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

[X] 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

FOR EXISTING FACILITIES, PROVIDE THE DATE *(yr., mo., & day)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

C	YR.	MO.	DAY
8	7 3	0 7	0 1

[ ] 2. NEW FACILITY *(Complete item below.)*

FOR NEW FACILITIES, PROVIDE THE DATE *(yr., mo., & day)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

YR.	MO.	DAY

B. REVISED APPLICATION *(place an "X" below and complete Item I above)*

[ ] 1. FACILITY HAS INTERIM STATUS

[ ] 2. FACILITY HAS A RCRA PERMIT

III. PROCESSES – CODES AND DESIGN CAPACITIES

A. PROCESS CODE – Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the form *(Item III-C)*.

B. PROCESS DESIGN CAPACITY – For each code entered in column A enter the capacity of the process.

1. AMOUNT – Enter the amount.
2. UNIT OF MEASURE – For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER *(barrel, drum, etc.)*	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D79	GALLONS OR LITERS
LANDFILL	D80	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D81	ACRES OR HECTARES
OCEAN DISPOSAL	D82	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D83	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER *(Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Item III-C.)*	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G	LITERS PER DAY	V	ACRE-FEET	A
LITERS	L	TONS PER HOUR	D	HECTARE-METER	F
CUBIC YARDS	Y	METRIC TONS PER HOUR	W	ACRES	B
CUBIC METERS	C	GALLONS PER HOUR	E	HECTARES	Q
GALLONS PER DAY	U	LITERS PER HOUR	H		

EXAMPLE FOR COMPLETING ITEM III *(shown in line numbers X-1 and X-2 below)*: A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

C	D	U	P							T/A	C	1	

LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT	B. 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5				
X-2	T 0 3	20	E		6				
	D 8 0	100	A		7				
2					8				
3					9				
4					10				

NOV 19 1990

CONTINUE ON REVERSE

Continued from the front.

II. PROCESSES *(continued)*

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESSES *(code "T04")*. FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

IV. DESCRIPTION OF HAZARDOUS WASTES

A. EPA HAZARDOUS WASTE NUMBER — Enter the four—digit number from 40 CFR, Subpart D for each listed hazardous waste you will handle. If you handle hazardous wastes which are not listed in 40 CFR, Subpart D, enter the four—digit number*(s)* from 40 CFR, Subpart C that describes the characteristics and/or the toxic contaminants of those hazardous wastes.

B. ESTIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non—listed waste*(s)* that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:
   For listed hazardous waste: For each listed hazardous waste entered in column A select the code*(s)* from the list of process codes contained in Item III to indicate how the waste will be stored, treated, and/or disposed of at the facility.
   For non—listed hazardous wastes: For each characteristic or toxic contaminant entered in column A, select the code*(s)* from the list of process codes contained in Item III to indicate all the processes that will be used to store, treat, and/or dispose of all the non—listed hazardous wastes that possess that characteristic or toxic contaminant.
   Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code*(s)*.

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: HAZARDOUS WASTES DESCRIBED BY MORE THAN ONE EPA HAZARDOUS WASTE NUMBER — Hazardous wastes that can be described by more than one EPA Hazardous Waste Number shall be described on the form as follows:

1. Select one of the EPA Hazardous Waste Numbers and enter it in column A. On the same line complete columns B,C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other EPA Hazardous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other EPA Hazardous Waste Number that can be used to describe the hazardous waste.

EXAMPLE FOR COMPLETING ITEM IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non—listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
X-1	K054	900	P	T03 D80	
X-2	D002	400	P	T03 D80	
X-3	D001	100	P	T03 D80	
X-4	D002				included with above

 CONTINUE ON PAGE 3

Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

Form Approved OMB No. 158-S80004

EPA I.D. NUMBER (enter from page 1)	FOR OFFICIAL USE ONLY
IND077005916 T/A 1 C	W DUP T/A 2 C DUP

IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

LINE NO.	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	F006	8.6	A	D80	CO-DISPOSAL AS REQUIRED BY INDIANA E.P.A.
2	K087	2.0	A	D80	" " "
3	F005	0.3	A	D80	" " "
4	F003	0.3	A	D80	" " "
5		0.2	A	D80	CO-DISPOSAL - CALCIUM SULFA FROM IND. 047030226
6		6.1	A	D80	CO-DISPOSAL - TERMINAL WASTE WATER TREATMENT SLUDGE FROM IND 005444062 (FUTURE DISPOSAL - PRESENTLY STORED ON MFGRS. PLANT SITE
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

Continued from the front.

IV. DESCRIPTION OF HAZARDOUS WAST (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE

EPA I.D. NO. (enter from page 1)

F IND077005916 T/A 6

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground—level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE (degrees, minutes, & seconds)	LONGITUDE (degrees, minutes, & seconds)
41 36 55.3	87 25 39.5

VIII. FACILITY OWNER

☐ A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. (area code & no.)
E Gary Development Company, Inc.	219-944-7858

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE
F 479 N. Cline Ave., P.O. Box 6056	G Gary	IN	46406

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)	B. SIGNATURE	C. DATE SIGNED
Lawrence Hagen, Vice President	Lawrence H. Hagen	November 18, 1980

X OPERATOR CERTIFICATION

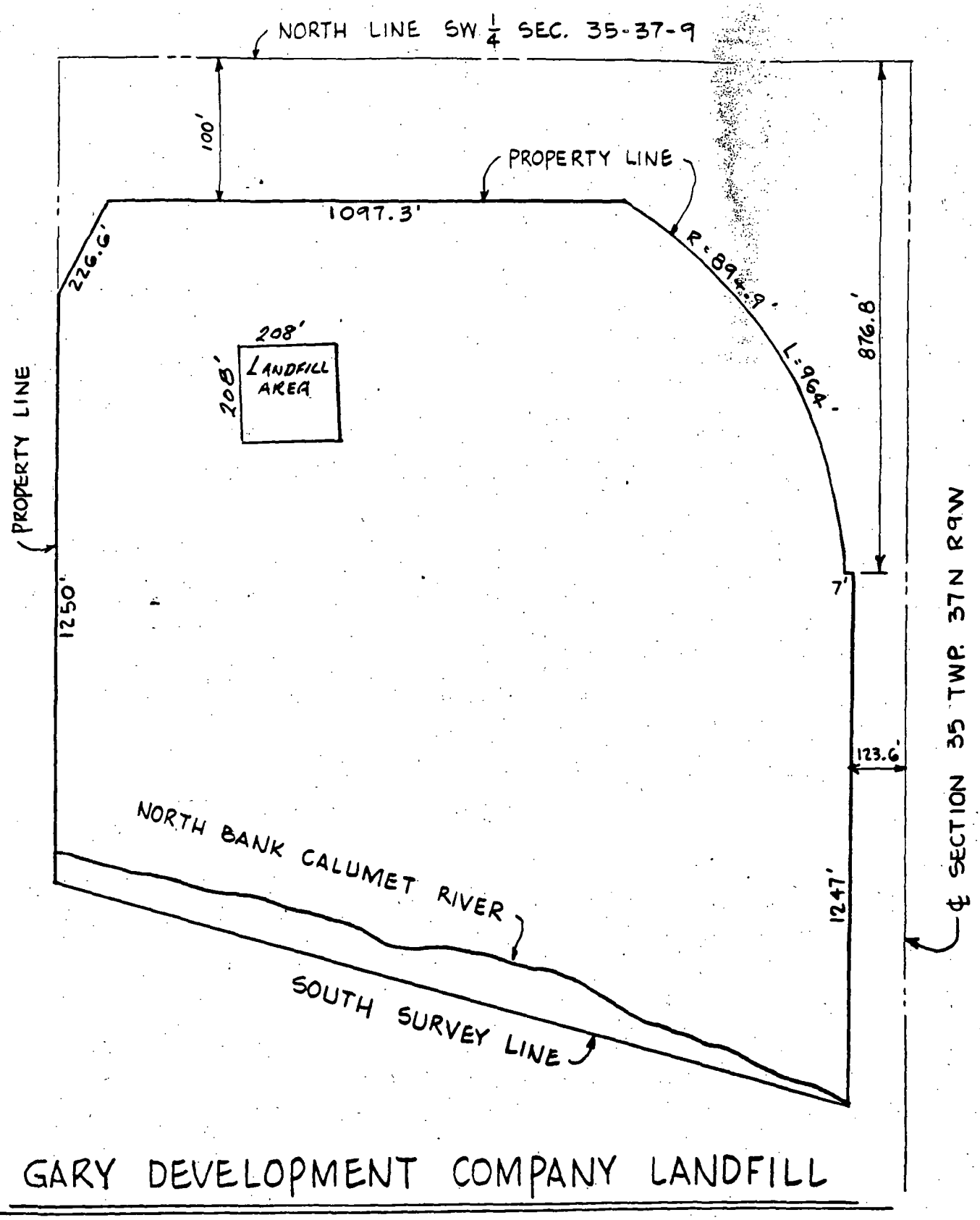
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)	B. SIGNATURE	C. DATE SIGNED

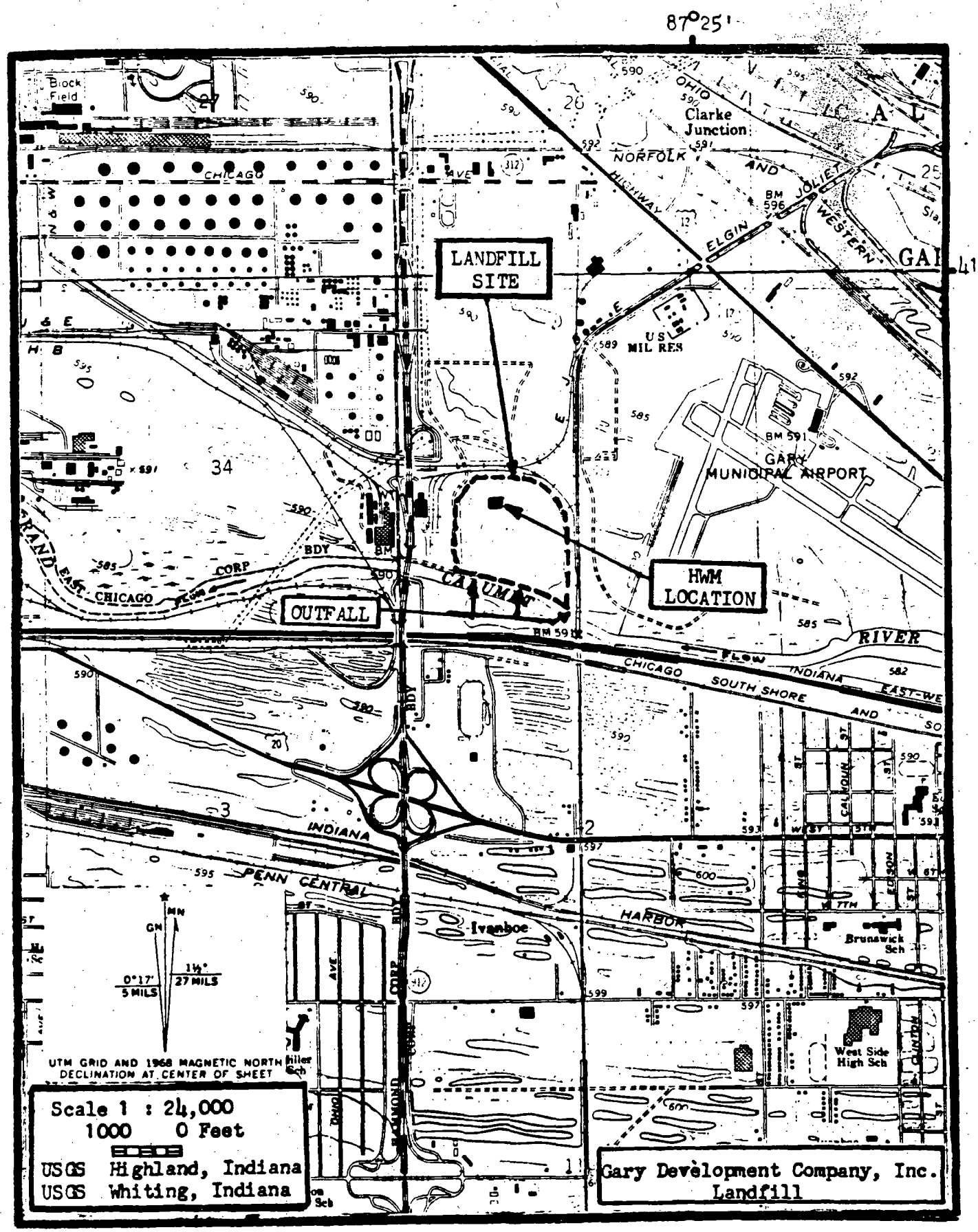
 CONTINUE ON PAGE 5

Continued from page 4

V. FACILITY DRAWING (see page 4)



GARY DEVELOPMENT COMPANY LANDFILL


87°25'
41°37'30
LANDFILL SITE
HWM LOCATION
OUTFALL
Clarke Junction
NORFOLK AND WESTERN
ELGIN JOLIET
US MIL RES
GARY MUNICIPAL AIRPORT
CHICAGO
CALUMET
RIVER
FLOW
INDIANA
CHICAGO SOUTH SHORE AND
PENN CENTRAL
HARBOR
Ivanboe
Brunswick Sch
West Side High Sch
EAST CHICAGO
Block Field
MN
GN
0°17'
5 MILS
1½°
27 MILS
UTM GRID AND 1968 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
Scale 1 : 24,000
1000 0 Feet
USGS Highland, Indiana
USGS Whiting, Indiana
Gary Development Company, Inc.
Landfill

JUN 28 1982

JUN 21 12 55 PM '82

REGISTERED MAIL
RETURN RECEIPT REQUESTED

Mr. Lawrence Hagan
Gary Development Company, Inc.
870 North Cline Avenue
Gary, Indiana 46406

"Complainant's Exhibit No. 2"

Mr. Hagan:

As you requested at our June 18, 1982 meeting, I am apprising you of your status in the Federal hazardous waste management system. In completing a review of our files regarding the submission of U.S. Environmental Protection Agency (USEPA) Form 8700-12, we have determined that your facility did not submit this form as required by the Resource Conservation and Recovery Act (RCRA). As a result of that non-submittal, it is USEPA's advisory opinion that your facility does not have interim status as defined in 40 CFR 122.23. Without having interim status or a final Federal RCRA permit your facility is operating as a hazardous waste management facility in violation of RCRA.

The USEPA recognized that many facilities may have failed to submit or be timely with their notifications due to a variety of reasons. Therefore, a policy was established by which the Agency may exercise discretion in allowing those facilities to continue to operate, under a Compliance Order.

Among the items USEPA considers in exercising its discretion is possession of a State permit or license to operate as a hazardous waste facility. The USEPA will not issue an Order allowing a facility to operate unless the State is also allowing the facility to operate. A facility must be sanctioned to operate by both the State and Federal Agencies.

Please feel free to contact me if you have any further questions.

Sincerely yours,

William Miner, Chief
Technical Programs Compliance Section

cc: Indiana State Board of Health ✓
Terry K. Miestand

FEB 08 1984

"Complainant's Exhibit No. 3"

IND 077 005 916

John M. Kyle III
Barnes and Thornburg
1313 Merchants Bank Building
Indianapolis, Indiana 46204

Re: Gary Development Landfill
Gary, Indiana

Dear Mr. Kyle:

Thank you for your letter of October 7, 1983, requesting the removal of Gary Development Landfill from the Federal hazardous waste management system. Based upon the information you have supplied, plus other information available to this office, the facility is required to have a Resource Conservation and Recovery Act (RCRA) permit, and may not be withdrawn from the hazardous waste system.

Your request is based upon the quantity of hazardous wastes disposed of at the landfill. RCRA regulations do not provide for waivers of closure or post-closure requirements based upon the quantity of wastes handled. Furthermore, we have learned that your statements concerning the wastes that Gary Development has accepted from American Chemical Service, Inc. are inaccurate in several respects. A recent inspection of American Chemical Service revealed that 32 shipments of hazardous waste, labelled F005, were sent by manifest to Gary Development in 1981. Each shipment was approximately 2750 gallons. In addition, we were informed that a number of shipments of the same material were erroneously sent without manifests from November 19, 1980, until early 1981. This contradicts your statement that only four to six loads were received from American Chemical Service.

The hazardous waste number F005 represents certain non-halogenated solvents which are listed as hazardous wastes for the properties of ignitability and toxicity. Our understanding of the process which generates the wastes leads us to believe that any of the hazardous waste types handled by American Chemical Service might be present in the wastes sent to Gary Development. This includes hazardous waste numbers F001, F002, F006, U147, U031, U112, U002, U154, D001 and F003. The first three wastes in this list are hazardous because of their toxicity. American Chemical Service also handles paint waste, which may be hazardous due to heavy metal toxicity. Therefore, we find your assertion that American Chemical Service waste is only ignitable to be invalid.

Finally, we discovered that the American Chemical Service wastes were not mixed with sand to eliminate ignitability, as your January 28, 1983, letter to George Farland states. The co-mixing of sand and wastes did not begin until late 1981 or early 1982.

With respect to your question concerning the applicability of 40 CFR Parts 264 and 265 to the activities performed by Gary Development Landfill, please find enclosed a copy of the November 22, 1983, Federal Register. This amendment clarifies the applicability of the hazardous waste regulations to existing facilities which fail to qualify for interim status, such as Gary Development. On page 53719, it is stated that "EPA has both the statutory and regulatory authority to apply either the Part 264 general permitting standards or the Part 265 interim status standards to existing facilities which have failed to qualify for interim states." The document sets forth an amendment to 40 CFR §265.1 which establishes that Part 265 is the appropriate set of standards applicable to facilities such as Gary Development Landfill, until a permit is issued. Since the State of Indiana has received Phase I interim authorization, the Indiana State Board of Health (ISBH) is responsible for administering the interim status standards in lieu of the Federal government. Indiana has clarified the applicability issue by deleting §265.1(b) in their adoption of Part 265, and inserting language which makes the standards applicable to all hazardous waste facilities regardless of permit status.

Factors which ISBH may consider in approving any closure and post-closure plans submitted by the landfill do include the quantity, types of waste, and methods of management. Because of the landfill's repeated ratings of "unacceptable operation" in State inspections, its location in the Grand Calumet River floodplain, and the actual quantity and nature of American Chemical Service waste disposed of there, we believe that proper closure will involve a design with numerous protective measures.

We have considered the above factors, plus the Agreed Order reached between the Environmental Management Board and Gary Development in early 1983, and have concluded that it is not in the public interest for Gary Development Landfill to be issued an Interim Status Compliance Letter for continued hazardous waste operation. Since the Landfill does not have interim status or a permit, closure and post-closure are required.

In summary, (1) Gary Development Landfill is in violation of RCRA Section 3005, plus 40 CFR §§270.2(c), 270.10(a) and 124.3(a), for disposal of hazardous wastes without a permit; (2) the landfill is subject to regulation under 329 Indiana Administrative Code, Article 4; and (3) the landfill must undergo closure pursuant to these regulations to avoid enforcement action by this office.

Please contact Mr. Richard Shandross, at (312) [illegible], if you have any questions about this matter.

Sincerely yours,

Karl J. Klepitsch, Jr., Chief
Waste Management Branch

Enclosure

cc: Guinn Doyle, ISPH
Jim Traylor, ISPH
Gary Development Landfill

bcc: Michael Berman, ORC

5HW;Shandross/mg 12/13/83 Disk #3

ORC		TYPIST	AUTHOR	STU #1 CHIEF	STU #2 CHIEF	STU #3 CHIEF	TPS CHIEF	WMB CHIEF	WMD DIRECTOR
	INITIALS	mg	RS	HC			[illegible]	KVK	
	DATE	12/14/83	12/14/83	1/27/84			1/31/84	2/1/84	

	Yes	No	Unknown
11. Have records been kept of analyses for parameters in 265.92(c) and (d)? 265.94(a)(1)	___	___	N/A
12. Have records been kept of ground-water surface elevations taken at the time of sampling for each well? 265.94(a)(1) (see 7.c) (illegible)	X	___	
13. Have records been kept of required elevations in 265.93(b)? 265.94(a)(1)	___	___	N/A
14. Have the following been submitted to the Regional Administrator 265.94(a)(2) :*			
a) Initial background concentrations of parameters listed in 265.92(b) within 15 days after completing each quarterly analysis required during the first year?	___	___	N/A
b) For each well, have any parameters whose concentrations or values have exceeded the maximum contaminant levels allowed in drinking water supplies been separately identified?	___	___	N/A
c) Annual reports including:			
1) Concentrations or values of parameters used as indicators of ground-water contamination for each well along with required evaluations under 265.93(b)?	___	___	N/A
2) Any significant differences from initial background values in up-gradient wells separately identified?	___	___	N/A
3) Results of the evaluation of ground-water surface elevations?	___	___	N/A

*EPA will be proposing (Spring 1982) to replace this reporting requirement with an exception reporting system where reports will be submitted only where maximum contaminant levels or significant changes in the contamination indicators or other parameters are observed. EPA has delayed compliance stage for 14 a) above until August 1, 1982 (Federal Register, February 23, 1982, p.7841-7842) to be coupled with exception reporting in the interim.

APPENDIX B

GROUND-WATER MONITORING AND ALTERNATE SYSTEM
TECHNICAL INFORMATION FORM

1.0 Background Data:

Company Name: Gary Development ; EPA I.D.#: IND077205916

Company Address: Box 6056
Gary, Indiana 46406

Inspector's Name: John Wilson ; Date: 9/19/84

1.1 Type of facility (check appropriately):

1.1.1 surface impoundment X
1.1.2 landfill ___
1.1.3 land treatment facility ___
1.1.4 disposal waste pile ___

1.2 Has a ground-water monitoring system been established? (Y/N) Y

1.2.1 Is a ground-water quality assessment program outlined or proposed? (Y/N) N

If Yes,

1.2.2 Was it reviewed prior to the site visit? (Y/N) N/A

1.3 Has a ground-water quality assessment program been implemented or proposed at the site? (Y/N) N

If yes, Appendix C, Ground-Water Quality Assessment Program Technical Information Form must be utilized also.

2.0 Regional/Facility Map(s)

2.1 Is a regional map of the area, with the facility delineated, included? (Y/N) N

If yes,

2.1.1 What is the origin and scale of the map? ___

2.1.2 Is the surficial geology adequately illustrated? (Y/N) N/A

2.1.3 Are there any significant topographic or surficial features evident? (Y/N) Y

If yes, describe old borrowpit-directed to strip landfill - Calumet River on S perimeter

2.1.4 Are there any streams, rivers, lakes, or wet lands near the facility? (Y/N) Y

If yes, indicate approximate distances from the facility Calumet River -

2.1.5 Are there any discharging or recharging wells near the facility? (Y/N) Y

If yes, indicate approximate distances from the facility. sanitary pump-well @ facility office

2.2 Is a regional hydrogeologic map of the area included? (This information may be shown on 2.1) (Y/N) N

If yes:

2.2.1 Are major areas of recharge/dishcarge shown? (Y/N) N

If yes, describe.

2.2.2 Is the regional ground-water flow direction indicated? (Y/N) N/A

2.2.3 Are the potentiometric contours logical? (Y/N) N/A
If not, explain.

2.3 Is a facility plot plan included? (Y/N) Y

2.3.1 Are facility components (landfill areas, impoundments, etc.) shown? (Y/N) Y

2.3.2 Are any seeps, springs, streams, ponds, or wetlands indicated? (Y/N) Y

2.3.3 Are the locations of any monitoring wells, soil borings, or test pits shown? (Y/N) Y

2.3.4 Is the facility a multi-component facility? (Y/N) N

If yes:

2.3.4.1 Are individual components adequately monitored? (Y/N) ____

2.3.4.2 Is a Waste Management Area delineated? (Y/N) Y

2.4 Is a site water table (potentiometric) contour map included? (Y/N) N

If yes,

2.4.1 Do the potentiometric contours appear logical based on topography and presented data? (Consult water level data) (Y/N) N/A

2.4.2 Are groundwater flowlines indicated? (Y/N) N/A

2.4.3 Are static water levels shown? (Y/N) N/A

2.2.4 May hydraulic gradients be estimated? (Y/N) Y

2.4.5 Is at least one monitoring well located hydraulically upgradient of the waste management area(s)? (Y/N) Y

2.4.6 Are at least three monitoring wells located hydraulically downgradient of the waste management area(s)? (Y/N) Y

2.4.7 By their location, do the upgradient wells appear capable of providing representative ambient groundwater quality data? (Y/N) Y

If no, explain. _____

3.0 Soil Boring/Test Pit Details

3.1 Were soil borings/test pits made under the supervision of a qualified professional? (Y/N) Y

If yes,

3.1.1 Indicate the individual(s) and affiliation(s): Salisbury Eng

3.1.2 Indicate the drilling/excavating contractor, if known Salisbury Engineering, Griffith, Indiana

3.2 If soil borings/test pits were made, indicate the method(s) of drilling/excavating:

- Auger (hollow or solid stem) X
- Mud rotary ___
- Air rotary ___
- Reverse rotary ___
- Cable tool ___
- Jetting ___
- Other, including excavation (explain) ___

3.3 List the number of soil borings/test pits made at the site

3.3.1 Pre-existing 6

3.3.2 For RCRA compliance ___

3.4 Indicate borehole diameters and depths (if different diameters and depths use TABLE B-1).

3.4.1 Diameter: ___

3.4.2 Depth: 40'

3.5 Were lithologic samples collected during drilling? (Y/N) Y

If yes,

3.5.1 How were samples obtained? (Check method(s))

- Split spoon
- Shelby tube, or similar X
- Rock coring ___
- Ditch sampling ___
- Other (explain) ___

INFORMATION TABLE B-1

BORING NO.	DEPTH	DIAMETER

3.5.2 At what interval were samples collected? _____

3.5.3 Were the deposits or rock units penetrated described? (boring logs, etc.) (Y/N) Y

3. If test pits were excavated at the site, describe procedures. _____

4.0 Well Completion Detail

4.1 Were the wells installed under the supervision of a qualified professional? (Y/N) N

If yes:

4.1.1 Indicate the individual and affiliation, if known Put in by Gary Land Development using backhoe

4.1.2 Indicate the well construction contractor, if known GLD

4.2 List the number of wells at the site

4.2.1 Pre-existing 4 (for Ind. Stk Compliance)

4.2.2 For RCRA Compliance ____

4.3 Well construction information (fill out INFORMATION TABLE B-2)

4.3.1 If PVC well screen or casing is used, are joints (couplings): 2 PVC 2 steel

- Glued on X
- Screwed on ____

4.3.2 Are well screens sand/gravel packed? (Y/N) Y

4.3.3 Are annular spaces sealed? (Y/N) N

If yes, describe:

- bentonite slurry ____
- Cement grout ____
- Other (explain) _____

_____

- Thicknesses of seals _____

4.3.4 If "open hole" wells, are the cased portions sealed in place? (Y/N) N/A

If yes, describe how: _____

_____

_____

4.3.5 Are there cement surface seals? (Y/N) N

If yes,

- How thick? _____

4.3.6 Are the wells capped? (Y/N) Y

If yes,

- Do they lock? (Y/N) N

4.3.7 Are protective standpipes cemented in place? (Y/N) N

4.3.8 Were wells developed? (Y/N) N

If yes, check appropriate method(s):

- Air lift pumping ____
- Pumping and surging ____
- Jetting ____
- Bailing ____
- Other (explain) _____

_____

5.0 Aquifer Characterization

5.1 Has the extent of the uppermost saturated zone (aquifer) in the facility area been defined? (Y/N) N

If yes,

5.1.1 Are soil boring/test pit logs included? (Y/N) N

5.1.2 Are geologic cross-sections included? (Y/N) N

5.2 Is there evidence of confining (low permeability) layers beneath site? (Y/N) Y

If yes, 80' of clay - permeability 10^{-8} to 10^{-9}

5.2.1 Is the [illegible] extent and continuity indicated? (Y/N) Y

5.2.2 Is there [illegible]y potential for saturated conditions (perched [illegible]ater) to occur above the uppermost aquifer? (Y/N) Y

If yes, give details: _____

a) Should or is this perched zone being monitored? (Y/N) Y

Explain Sand acts as Groundwater Table Aquifer

5.2.3 What is the lithology and texture of the uppermost saturated zone (aquifer)? Fine sand - white-gold - fairly pure to 35', then clay lenses, then solid clay

5.2.4 What is the saturated thickness, if indicated? 37'-38'

5.3 Were static water levels measured? (Y/N) N

If yes,

5.3.1 How were the water levels measured (check method(s)).

- Electric water sounder ____
- Wetted tape ____
- Air line ____
- Other (explain) ____

5.3.2 Do fluctuations in static water levels occur? (Y/N) N/A

If yes,

5.3.2.1 Are they accounted for (e.g. seasonal, tidal, etc.)? (Y/N) N/A

If yes, describe: _____

5.3.2.2 Do the water level fluctuations alter the general ground-water gradients and flow direction? (Y/N) N/A

If yes,

5.3.2.3 Will the effectiveness of the wells to detect contaminants be reduced? (Y/N) N/A

Explain _____

5.3.2.4 Based on water level data, do any head differentials occur that may indicate a vertical flow component in the saturated zone? (Y/N) ?

If yes, explain _____

5.4 Have aquifer hydraulic properties been determined? (Y/N) Y (?)

If yes,

5.4.1 Indicate method(s):

- Pumping tests ____
- Falling/constant head tests ____
- Laboratory tests (explain) ____

Estimated

5.4.2 If determined, what are the values for:

- Transmissivity 15,000 gpd/ft
- Storage coefficient ____
- Leakage ____
- Permeability 450 gpd/ft²
- Porosity ____
- Specific capacity ____

5.4.3 In cases where several tests were undertaken, were discrepancies in the results evident? (Y/N) N/A

If yes, explain _____

5.4.4 Were horizontal ground-water flow velocities determined? (Y/N) N

If yes, indicate rate of movement _____

6.0 Well Performance

6.1 Are the monitoring wells screened [illegible] the uppermost aquifer? (Y/N) Y

6.1.1 Is the full saturated thick[illegible] screened? (Y/N) N

6.1.2 For single completions, are [illegible] intake areas in the: (check appropriate levels)

- Upper portion of the aquifer ____
- Middle of the aquifer ____
- Lower portion of the aquifer X

6.1.3 For well clusters, are the intake areas open to different portions of the aquifer? (Y/N) N/A

6.1.4 Do the intake levels of the monitoring wells appear to be justified due to possible contaminant density and groundwater flow velocity? (Y/N) Y

7.0 Ground-Water Quality Sampling

7.1 Is a sampling (groundwater quality) program and schedule included? (Y/N) N

7.2 Are sample collection field procedures clearly outlined? (Y/N) N

7.2.1 How are samples obtained: (check method(s))

- Air lift pump ____
- Submersible pump ____
- Positive displacement pump ____
- Centrifugal pump ____
- Peristaltic or other suction-lift pump ____
- Bailer X
- Other (describe) ____

7.2.2 Are all wells sampled with the same equipment and procedures? (Y/N) Y

If no, explain ____

7.2.3 Are adequate provisions included to clean equipment after sampling to prevent cross-contamination between wells? (Y/N) N

7.2.4 Are organic constituents to be sampled? (Y/N) N

If yes,

7.2.4.1 Are samples collected with equipment to minimize absorption and volatilization? (Y/N) N/A

If yes,

Describe equipment _____

_____

_____

8.0 Sample Preservation and Handling

8.1 Have appropriate sample preservation and preparation procedures been followed (filtration and preservation where appropriate)? (Y/N) N

8.2 Are samples refrigerated? (Y/N) N (Samples delivered w/in 1h

8.3 Are EPA recommended sample holding period requirements adhered to? (Y/N) Y

8.4 Are suitable container types used? (1 gal. plastic jugs) (Y/N) Y

8.5 Are provisions made to store and ship samples under cold conditions (ice packs, etc.)? (Y/N) N

8.6 Is a chain of custody control procedure clearly defined? (Y/N) N

8.7 Is a specific chain of custody form illustrated? (Y/N) N

If yes,

8.7.1 Will this form provide an accurate record of sample possession from the moment the sample is taken until the time it is analyzed? (Y/N) N/A

9.0 Sample Analysis and Record Keeping

9.1 Is sample analysis performed by a qualified laboratory? (Y/N) unk

Indicate lab Lake County Health Department

9.2 Are analytical methods described in the records? (Y/N) N

9.2.1 Are analytical methods acceptable to EPA? (Y/N) unk

9.3 Are the required drinking water suitability parametters tested for? (Y/N) N

9.4 Are the required groundwater quality parameters tested for? (Y/N) N

9.5 Are the required groundwater contamination indicator parameters tested for? (Y/N) N

9.6 Are any analytical parameters determined in the field? (Y/N) N

Identify:

- pH ____
- Temperature ____
- Specific conductance ____
- Other (describe) ____

9.7 Is a plan included to record information about each sample collected during the groundwater monitoring program? (Y/N) N

9.7.1 Are field activity logs included? (Y/N) N

9.7.2 Are laboratory results included? (Y/N) Y

9.7.3 Are field procedures recorded? (Y/N) N

9.7.4 Are field parameter determinations included? (Y/N) N

9.7.5 Are the names and affiliation of the field personnel included? (Y/N) N

9.8 Are statistical analyses planned or shown for all water quality results where necessary? (Y/N) N

9.8.1 Is an analysis program set-up which adheres to EPA guidelines? (Y/N) N

9.8.2 Is Student's t-test utilized? (Y/N) N
If other evaluation procedure used, identify ____

9.8.3 Are provisions made for submitting analysis reports to the Regional Administrator? Submit to Indiana EMB (Y/N) N

10.0 Site Verification

10.1 Plot Plan indicating the locations of various facility components, ground-water monitoring wells, and surface waters? (Y/N) Y

10.1.1 Is the plot plan used for the inspection the same as in the monitoring program plan documentation? (Y/N) Y

If not, explain ____

10.1.2 Are all of the components of the facility identified during the inspection addressed in the monitoring program documentation? (Y/N) Y

If not, explain _____

10.1.3 Are there any streams, lakes or wetlands on or adjacent to the site? (Y/N) Y

If yes, indicate distances from waste management areas Calumet River & Border

10.1.4 Are there any signs of water quality degradation evident in the surface water bodies? (Y/N) N

If yes, explain _____

10.1.5 Is there any indication of distressed or dead vegetation on or adjacent to the site? (Y/N) N

If yes, explain _____

10.1.6 Are there any significant topographic or surficial features on or near the site (e.g., recharge or discharge areas)? (Y/N) N

If yes, explain _____

10.1.7 Are the monitor well locations and numbers in agreement with the monitoring program documentation? (Y/N) Y

If no, explain (No numbers on wells)

10.1.7.1 Were locations and elevations of the monitor wells surveyed into some known datum? (Y/N) N

If not, explain _____

10.1.7.2 Were the wells sounded to determine total depth below the surface? (Y/N) Y

If not, explain _____

10.1.7.3 Were discrepancies in total depth greater than two feet apparent in any well? (Y/N) UNK

If yes, explain no recorded depths available

10.1.8 Was ground water encountered in all monitoring wells? (Y/N) Y

If not, indicate which well(s) were dry _____

10.1.9 Were water level elevations measured during the site visit? (Y/N) Y

If yes, indicate well number and water level elevation _____

If not, explain See next two pages

WATER LEVEL MEASUREMENTS

Gary Land SITE

9/19/84 DATE

WELL NUMBER		TAPE HELD	MINUS TAPE WET	SUB TOTAL	MINUS STICK UP	WATER LEVEL (LSD)	LAND ELEV.	WATER LEVEL ELEV
N	measured	17	0.60	16.4	3.15	13.25		576.6
	reported						589.85	
S	measured	6	1.46	4.54	1.5	3.04		583.96
	reported						587.0	
E	measured	19	1.40	17.6	1.5	16.1		576.4
	reported						592.5	
W	measured	6	1.11	4.89	3.41	1.48		586.71
	reported						588.19	
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							

Harding Lawson Associates

PLATE

JOB NUMBER APPROVED DATE REVISED DATE

WELL DEPTH MEASUREMENTS

Gary Land SITE

9/19/86 DATE

* Estimated from topo plots of facility

WELL NUMBER	-	TAPE DROPPED	MINUS FACTOR	SUB TOTAL	MINUS STICK UP	TOTAL DEPTH (LSD)	LAND ELEV.	BOTTOM ELEV.	
N	measured	58.06	35.97	22.09	3.15	19.94		570.91	
	reported						589.55		
S	measured	51.68	35.97	15.71	1.5	14.21		572.79	casing bent thru
	reported						587.0		
E	measured	55.92	35.97	19.95	1.5	18.45		574.05	
	reported						592.5		
W	measured	51.18	35.97	15.21	3.41	11.8		576.39	
	reported						550.19		
	measured								
	reported								
	measured								
	reported								
	measured								
	reported								
	measured								
	reported								
	measured								
	reported								

Harding Lawson Associates

N & S - 6" steel
W & E - 6" PVC

All 4 wells contain sediment

APPENDIX B

APPENDIX B

DOCUMENTS OBTAINED

Addendum to 1973 report

Engineering Report
Proposed Commercial Sanitary Landfill Project
May 4, 1973

Joseph [illegible], P.E.

Because there is no other entrance to the site (aided by the immediate protection [illegible] by the railroad rights-of-way on the north and east boundaries, the Grand [illegible]ust River on the south and the Vulcan Detinning plant on the west) there should be little problem with unauthorized entrance and trespass at the site.

Geology:*

Bedrock, in the vicinity of the proposed sanitary landfill site, is approximately 140 to 145 feet below the land surface. The upper surface of the rock is a dolomite or limestone, fine to medium grained, of the Silurian system. The surface of the rock slopes generally to the northwest to a low region west of the site. The material above the bedrock consists of unconsolidated rocks of the Quaternary system, Recent and Pleistocene. Most of the material is believed to have been deposited as a result of glaciation during the Pleistocene time. Briefly described from the bottom up, the material consists of the following:

A) A dense gray clay till, impervious, which rests on the bedrock and tends to act as a confining stratum for the water in the limestone below.

B) Immediately above the clay till is a layer of fine sand approximately 25 to 35 feet in thickness which forms the surface strata. Within the site boundary this material has been removed as borrow for area highway construction.

* Based on information reported in Bulletin No. 31, "Geohydrology and Ground Water Potential of Lake County, Indiana" prepared by the U. S. Geological Survey for the Indiana Department of Natural Resources.

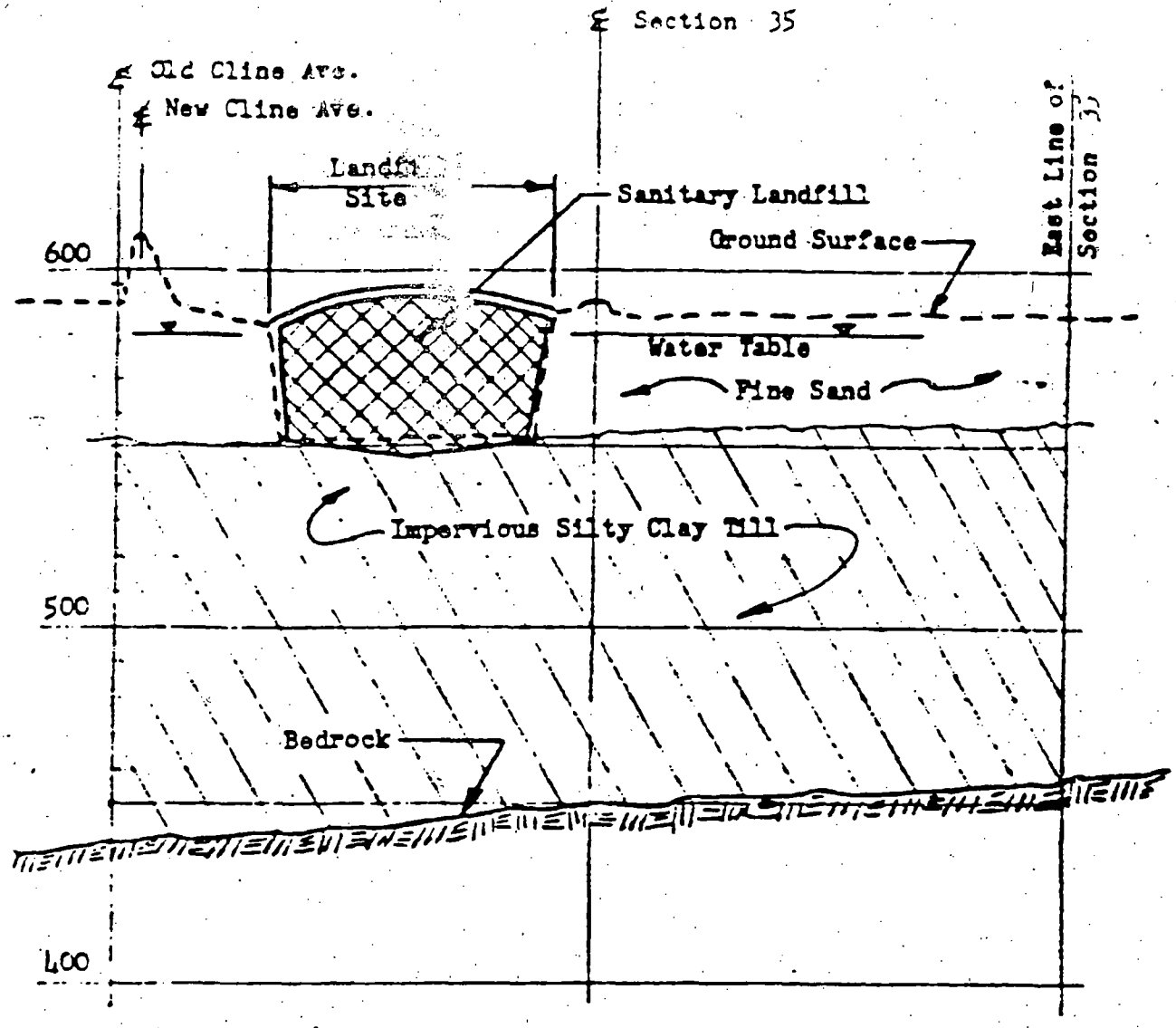
C) Immediate surface soil characteristics, prior to the removal of the surface material, appear to have been a continuation of the Oakville [illegible] as complex prevalent in the adjoining undeveloped land.

A cross section showing the approximate elevation of the bedrock, the confining clay till and the overlying sandy strata is shown on Plate No. 1.

Also shown is the approximate ground water table in the overlying sandy strata.

Although very few wells have been developed in the sandy surface strata near the proposed development site, primarily because of the availability of adequate water supply from the nearby major public water utilities, there is sufficient information to indicate that it is a relatively poor aquifer of limited capability.

Of major concern in establishing a sanitary landfill site is the need to be certain of proper protection to underlying and adjacent aquifers. As shown on Plate No. 1, the original elevation of the ground surface prior to its excavation as a borrow pit was approximately 585 to 590. With the establishment of the finished sanitary landfill surface at approximately elevation 590 and the base of the landfill at approximately elevation 550 on the underlying impervious clay strata, there will be some 100 to 110 feet of impervious clay protecting the underlying sandstone aquifer. The construction of an impervious clay seal around the perimeter of the sanitary landfill as construction progresses will adequately protect the adjoining sandy surface aquifer from contamination.



SECTION

Looking North through the South Quarter of Section 35

Scale: Horizontal - 1" = 1000 feet

Vertical - 1" = 50 feet

Basic information from U.S.G.S. Quadrangle Map (Highland) and Bulletin No. 31, " Geohydrology & Ground Water Potential of Lake County, Indiana", Division of Water, Indiana Department of Natural Resources.

PLATE NO. 1

Topography:

The site is located in an area that, prior to its development industrially, was characterized by a series of beach ridges and dunes that represented former strand lines and shoreline dunes of geologic Lake Michigan elevations. These former dune ridges are clearly visible on nearby adjoining undeveloped property. They are particularly characterized as long narrow sandy dunes running generally east and west, parallel to the Lake Michigan shoreline, and varying in elevation from five to fifteen feet. These soils are identified on the soils map as the Oakville-Tawas complex. Prior to its development as a borrow pit, the land drained generally to the south to the Grand Calumet River. The open nature of the sandy soil together with the series of narrow dunes interrupting drainage undoubtedly permitted considerable direct percolation of rainfall as well as a relatively high rate of evapotranspiration.

Since the site has been excavated, and the berm separating the site from the Grand Calumet River has been raised to provide an access roadway, there is very little run-off from the site. Precipitation falling within the site tends to remain in the basin, gradually leaving by percolation into the surrounding subsoil.

Since the railroads to the east and north and "Old" Cline Avenue to the west are at approximately elevation 590, it is the intention of the sanitary landfill construction to raise the level of the site to approximately elevation 590 (somewhat higher at the center) with drainage swales to carry surface run-off from the completed site south to the Grand Calumet River. On completion, the completed fill will be at the approximate elevation of

surrounding land with adequate surface drainage slopes to minimize percolation through the impervious cover material for the underlying compacted sanitary landfill material.

Soils:

During its use as a borrow pit, the surface sand on the site have been removed to the underlying impervious clay till at a depth of approximately 25 to 30 feet. As indicated by available geologic studies* and substantiated by the perimeter borings shown on Exhibit No. 2, the surrounding surface soil to a depth of 25 to 30 feet is sand, generally fine to medium, somewhat silty, slightly to moderately calcerous with occasional thinly laminated silt and clay lenses.

Estimated average hydraulic properties are:

Permeability	-	Approximately 450 gpd per square foot
Transmissability	-	Approximately 15,000 gpd per foot

Because most of the available sand within the site has been removed, (some 300,000 C.Y. remain) it will be necessary to import impervious cover material and side separation material. Liner material for the sides to protect the first pass of sanitary landfill construction, however, can be obtained from the impervious clay till existing on the site bottom.

During its history of use as a borrow pit, since the late 1950's, the site has been dewatered for two extended periods of time. (Each period lasting for a number of years). The Owner noted no difficulty in economically

* Bulletin No. 31, "Geohydrology and Ground Water Potential of Lake County, Indiana and Bulletin No. 10, "Ground Water Resources of Northwestern Indiana, Lake County."

pumping and maintaining the site dry and noted that there was little, if any, seepage into the dewatered pit from the Grand Calumet River. The silts and bottom deposits in the river in the area apparently effectively seal the river from the surrounding subsoil.

The estimated average permeability of the underlying clay is approximately 0.003 GPD per square foot.

Surface Drainage:

As previously noted, there is no effective surface drainage from the present site. Surface drainage from the proposed finished sanitary landfill surface will be by means of sheet drainage and perimeter swales draining to the south along the east and west boundaries of the site to the Grand Calumet River.

The two moderately elevated railroad rights-of-way and the new elevated new Cline Avenue improvement effectively deter any surface drainage from surrounding properties onto the site. Drainage from the Gary Municipal Airport located to the east is from its own internal system south to the Grand Calumet River and drainage from the industrial property located to the north across the E.J. & E. Railroad right-of-way is conducted artificially to the south by means of major drainage ditches bordering Cline Avenue. Surface drainageways at the west edge of the site will be coordinated with the needs of the Vulcan Materials Company site.

Water Supply:

There are very few existing domestic water supply wells in the immediate vicinity of the site. The two nearest commercial wells are one located approximately 350 feet west of the site supplying sanitary service water

to the Vulcan Detinning Company and one located approximately 3/4 mile east and north of the site providing sanitary service water to the Gary Municipal Airport building. There is another group of wells serving a small-number of private homes located approximately 1/2 to 3/4 mile northeast of the site on Hobart Street in Gary. All of these wells are small and shallow, averaging 30 to 40 foot in depth, with yields in the 8 to 10 gpm range. All of these wells were in existence and operation during previous periods of dewatering at the site and, so far as is known, were not adversely affected by the dewatering operation.

There are no public ground water supplies in the immediate vicinity of the site. The nearby communities of Gary, Hammond, East Chicago and Whiting are all served by major public water supply systems which utilize Lake Michigan as a source of raw water. Most of the nearby industrial development is served by connections to these public water supply systems. So far as is known, there are no nearby industrial users of ground water.

Although detail studies of the few individual domestic wells in the area have not been made, there are no known publicized instances of ground water contamination affecting them despite the extensive and long term industrial dumping which has been prevalent in the general area. It is expected that the impervious lining and cover proposed for the sanitary landfill on the site, together with the improved drainage and plans for leachate control, will be more than sufficient to adequately protect these few domestic wells.

Page Two

DESCRIPTION:-

Add the following after paragraph 1:

As shown on the accompanying drawing number 1, the site has been dewatered and about 40% of the site area has been partially filled.

Add the following after paragraph 2:

As shown on the original exhibit number 1, the Gary Municipal Airport is located east of the landfill site across the E.J. & E. Railroad right of way. The end of the nearest airport runway is approximately 1300 feet from the east boundary of the landfill site. The landfill plan was approved, and construction and operations commenced prior to the promulgation of the F.A.A. guidance memorandum of October 16, 1974, concerning the relation of landfill siting and public airports.

Page Three

ACCESS: No Change

Page Four

GEOLOGY: No Change

Page Five

Add the following after paragraph 5:

Environmental Regulatory and Economic Concerns which have developed since 1973 have dictated the need to raise the finished elevation of the landfill and excavate further into the underlying impervious clay to provide materials.

for the perimeter barrier seals, daily cover and final cover on the landfill site. The thicker perimeter barriers now proposed will offer even more secure protection to the shallow adjoining sandy surface aquifer, as well as preventing infiltration into the fill excavation of the apparently contaminated ground water from adjoining properties, and the deeper excavation into the clay substrata will still provide 70 to 80 feet of underlying impervious clay to protect the sandstone aquifer below.

Page Six

The finished grade elevations on Plate Number 1 and the bottom of excavation elevations are to be modified as shown on Drawings Nos. 6 thru 14.

Page Seven

TOPOGRAPHY: No Change

Page Eight

Add the following after the first paragraph:

The proposed new finished grade for the landfill will raise the elevation of the site slightly above that of the new Cline Avenue bridge over the Grand Calumet River with the general drainage pattern remaining the same, that is, perimeter drainage swales to carry surface runoff along the easterly and westerly boundaries of the site south to the Grand Calumet River

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE 738-2020 OR 663-0780

PETER STECY M.D.
HEALTH COMMISSIONER

Aug. 1, 1984

Gary Development Co.
Box 6056
Gary, Ind. 46406

Attention: Mr. Larry Hagen

Tabulated below are the data obtained for 4 perimeter Well samples that you delivered to this laboratory on July 26, 1984.

Well	pH	Chloride ppm	Chemical Oxygen Demand ppm	Calcium Hardness ppm	Total Iron ppm	Total Dissolved Solids ppm
North	7.6	100	1300	170	1.3	900
South	6.65	615	100	3090	1.4	1200
West	7.45	610	90	450	.7	1190
East	7.30	150	500	700	2.3	1190

Attached is an invoice concerning fees to cover the costs of Tests.

Sincerely,

Andrew F. Livovich
C. Chemist

AFL/lr

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE: 738-2020 OR 663-0760

PETER STECY M.D.
HEALTH COMMISSIONER

September 1, 1983

Gary Development Co.
Box 6056
Gary, Indiana 46406

Attention: Mr. Larry Hagen:

Given below are data obtained for three Well samples from Sanitary Landfill 45-2 that you delivered to our Laboratory on August 30, 1983.

Samples	pH	Chloride	Chem. Oxygen Demand	Calcium Hardness	Total Iron	Total Dissolved Solids
North	7.55	150	40	120	1.2	950
South	7.30	135	120	116	1.35	1100
West	7.25	250	130	80	0.1	1000

Kindly send check of $117.00 to the Lake County Health Dept. to cover costs of Tests.

Sincerely,

Andrew F. Livovich
C. Chemist

Copy:
Esther, Hoshaw

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2200 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE 738-2020 OR 663-0760

PETER STECY M.D.
HEALTH COMMISSIONER

May 11, 1983

Gary Development Co. Inc.
Box 6056
Gary, Ind. 46406
Attention: Mr. Larry Hagen

Given below are data obtained for three samples of Water from Sanitary landfill 45-2 that you delivered to our laboratory on May 10, 1983.

Samples	pH	Chloride	Chem. Oxygen Demand	Hardness	Iron	Total Dissolved Solids
North	7.6	200	76	260	.77	900
South	7.5	205	200	900	.80	1450
West	7.7	325	40	200	.48	1050

Kindly send a check of $117.00 to the Lake County Health Dept. to cover cost of tests.

Sincerely,

Andrew P. Livovich
C. Chemist

Copy:
E. Hoshaw

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT INDIANA 46307
PHONE 738 2020 OR 963 0760

PETER STECY M D
HEALTH COMMISSIONER

November 3, 1982

Gary Development Co. Inc.
Box 6056
Gary, Ind. 46406

Attention: Mr. Larry Hagen

Test data tabulated below were obtained for 4 Well samples from Sanitary land fill 45 - 2 that your personel delivered to our laboratory on November 1, 1982.

Samples	pH	Chloride	Chem Oxygen Demand	Total Hard	Total Iron	Total Dis Sol
North	7.2	500	60	240	.8	675
South	7.55	250	100	400	1.1	1125
West	8.1	350	550	80	.85	1175
Bldg.	8.5	100	60	40	.3	700

Sincerely,

Andrew F. Livovich
C. Chemist

AFL/lr

WATER SAMPLES FROM WELLS OCT. 29. 82

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE: 738-2020 OR 663-0760

PETER STECY M.D.
HEALTH COMMISSIONER

July 7, 1982

Gary Development Co. Inc.
Box 6056
Gary, Indiana 46406
Attention: Mr. Larry Hagen

Test data tabulated below were obtained for 3 samples of water from Sanitary Landfill 45 - 2 that were delivered to this laboratory on July 1, 1982.

Sample No.	pH	Chloride ppm	Chemical Oxygen Demand ppm	Total Hardness ppm	Total Iron ppm	Total Dissolved Solids ppm
1	8.1	400	240	400	5.0	1800
3	7.7	200	200	600	6.5	1000
5	8.4	100	70	120	0.0	1300

Sincerely,

Andrew F. Livovich
C. Chemist

AFL/lr

#1 WEST WELL BY VULCAN
#2 NORTH WELL BY ADMIXTURES PLANT - DRY - NO TEST
#3 SOUTH WELL BY RIVER
#5 WELL AT BUILDINGS 380' DEEP

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE 738-2020 OR 663-0760

PETER STECY M.D
HEALTH COMMISSIONER

November 14, 1983

Gary Development Co.
Box 6056
Gary, Ind. 46406
Attention: Larry Hagen:

Given below are data obtained for three Well Samples from Sanitary Landfill 45-2 that you delivered to our laboratory on November 10, 1983.

Parts Per Million

Well	pH	Chloride	Chem Oxygen Demand	Calcium Hardness	Total Iron	Total Dissolved Solids
North	7.4	140	80	330	2	800
South	7.7	180	200	135	2 3/4	1200
West	7.1	295	50	165	0.4	1150

Kindly send check of $117.00 to the Lake County Health Dept. to cover costs of tests.

Sincerely,

Andrew F. Livovich
C. Chemist

AFL/lr

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE 738-2020 OR 663-0760

PETER STECY M.D.
HEALTH COMMISSIONER

February 17, 1984

Gary Development Co.
Box 6056
Gary, Ind. 46406

Attention: Mr. Larry Hagen

Given below are test data obtained from three Well Samples that you delivered to our laboratory on February 15, 1984:

Parts Per Million

Well	pH	Chloride	Chem Oxygen Demand	Calcium Hardness	Total Iron	Total Dissolved Solids
North	7.5	75	400	410	1.45	750
South	7.1	420	500	1400	1.55	350
West	7.5	250	50	150	0.4	720

Kindly send check of $117.00 to the Lake County Health Dept. to cover costs of tests.

Sincerely,

Andrew F. Livovich
C. Chemist

AFL/lr

Copy:
Esther Hoshaw

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE 738-2020 OR 663-0760

~~PETER STECY M.D.~~
HEALTH COMMISSIONER

PEARL JOHNSON M.D.

GARY DEVELOPMENT CO.
BOX 6056
GARY, INDIANA 46406

May 3, 1984

Attn: Mr. Larry Hagen

Dear Mr. Hagen,

Test data tabulated below were obtained from three (3) well samples that you delivered to our laboratory on April 27, 1984.

PARTS PER MILLION

WELL	pH	CHLORIDE	CHEMICAL OXYGEN DEMAND	CALCIUM HARDNESS	TOTAL IRON	TOTAL DISSOLVED SOLIDS
NORTH	7.2	75	250	200	2.6	950
SOUTH	7.0	650	240	650	3.0	2650
WEST	7.4	525	50	120	0.45	1500

Enclosed is a Statement of Fees covering costs of Tests Performed. Please note the increase in fees based on new fee schedule of the Lake County Health Department.

Sincerely,

Andrew Livovich
Chief Chemist

SBH64-065
8/79
State Form 37488

LARRY HALAIN
219/944-7958
(7/22/82)

INDIANA STATE BOARD OF HEALTH
WATER AND WASTE SAMPLING FIELD DATA
Solid Waste Management Section

Facility and/or Project GARY ~~[illegible]~~ LAND DEV.

Location

Collector(s) BERNAUER, COPELAND

Sampling Date 2-A-82 No. of Stations ~~4~~ 3

Reasons for Sampling: Annual ✓ Complaint

Data Collection Enforcement

Note: Use station numbers for items listed below.

SAMPLE SOURCES:

Well(s)

Monitoring 3

Treated Supply

Untreated Supply

Stream

Upstream

Downstream

Other

Pond

Outfall

Marsh

Spring or Seep

Leachate

Sludge

Type(s)

Containerized Waste

Type(s)

Soil

Other

SAMPLING METHODS:

Pump ; Type

Bailer ✓ ; Type OWS

Grab ; Bottle types

Auger ; Sample depth(s)

Flushed casing prior to sampling _____

Filtered: Field ✓ Lab _____ Not filtered _____

Preserved: Field ✓ Lab _____ Not preserved _____

Refrigeration in field ✓ Blanks prepared _____

Samples split with _____ (please complete)

Photographs attached _____

Sample Description:

Sample No.	Color	Odor	Appearance	Other

PRECIPITATION DATA:

Rain _____ Snowmelt _____ Recent past (date) _____

Snow _____ During sampling _____ Not applicable _____

INFLUENTIAL FACTORS:

1) Proximity to other potential pollution sources (describe) ___

_____

_____

2) Well casing condition (note missing caps, casing cracks, condition of annular seals, etc.) No caps West, South, North

_____

3) Ponded water around casing(s) West, South

_____

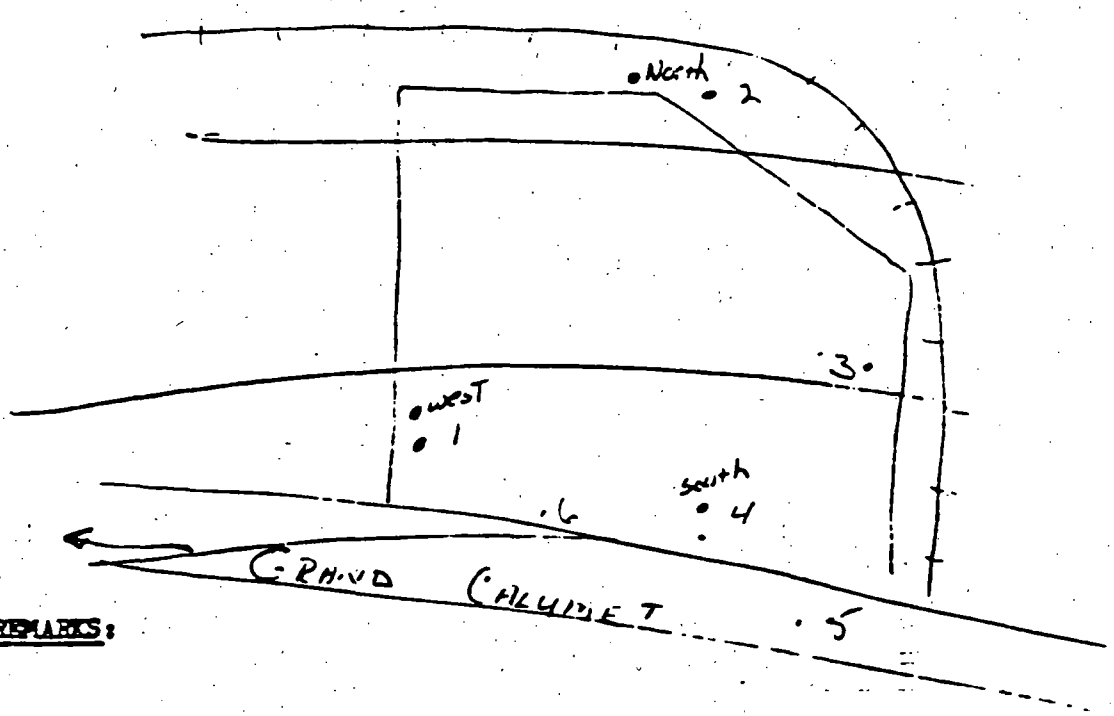
4) Water level(s) in casing(s) prior to flushing _____

_____

5) Well depth(s) _____

6) Other Well North dry

In the space below, accurately locate sampling stations on a sketch map. Include a north arrow, prominent landmarks, flow directions, potential pollution sources, and any other pertinent information.



REMARKS:

Delivered to Lab: 7 (Month) 22 (Day) 82 (Year) 8:30 (Time) A.M. P.M.

By: (Name) [illegible] (Title) [illegible]

(Division) LPC

WATER SAMPLE IDENTIFICATION SHEET

Sample Site: Gary Land Development

Station Number: ~~[illegible]~~ WEST

Sample Date: 7 (Mo. 11-12) 20 (Day 13-14) 82 (Yr. 15-16) AM/PM

Supervisor: SCHMIDT

Collector(s): BERNHUER, COPELAND

Delivered to lab: 7 (Mo.) 22 (Day) 82 (Yr.) AM/PM

By: [illegible]

Preservatives Added:	Kind	Lot No.	Amount
	$K_2Cr_2O_7$		20 ml
	HNO_3		5
	H_2SO_4		2
	NaOH		1

Sample Chlorinated _____ Not Chlorinated _____

	Field	Lab
No. of 1 Liter Plastic Bottles	5	5
No. of 2 Liter Plastic Bottles	1	1
No. of Bacteriological Bottles		
No. of Glass Jars or Bottles		
Total	6	6

Standard Procedure Followed: All / Some / None

PDES Number _____ (1-7) Outfall _____ (8-10)

17:
1. NPDES
2. SPC-15
3. WQ Study
4. Pollution complaint
5. Fish kill investigation

18:
1. Industry
2. Semi-Public
3. Municipal
4. Federal
5. Public Water Supply
6. State operation
7. Other

19 Sample Type:
1. Grab
2. 24-hour comp.
3. 8-hour comp.
4. 24-hour flow comp.
5. 8-hour flow comp.

20 Sample Interval

21:
0 - at outfall
1 - above outfall
2 - below outfall

22-26 Stream miles from outfall

LAB INFORMATION

Lab No. D2198 Date JUL 22 1982 8:30 (Mo. Day Yr. AM/PM)

Rec'd by: JB

Temp of samples when received: 4°C

Comments:

CODE	PARAMETERS	UNIT		LAB DATA
28-32 00410	Alkalinity Total $CaCO_3$	mg/l		34-41
00610	Ammonia-N	mg/l		
01002	Arsenic	ug/l	1	17.
00310	BOD_5	mg/l		
01027	Cadmium	ug/l	1	<2.
00940	Chlorides	mg/l	1	320.
01032	Chromium-Hex	ug/l		
01034	Chromium-Tot	ug/l	1	<10.
00335	COD	mg/l	1	160.
01042	Copper	ug/l		
00720	Cyanide-CN TOT	mg/l	1	0.007
00951	Fluoride	mg/l		
01045	Iron tot	ug/l	1	12,000.
01051	Lead	ug/l	1	40.
01055	Manganese	ug/l		
71900	Mercury	ug/l	1	0.1
01067	Nickel	ug/l		
[illegible]	[illegible]	mg/l		
00550	Oil & Grease	mg/l		
00403	~~[illegible]~~ SP.C	S.U.	1	3100 NMHOS/CM
32730	Phenol	ug/l	1	<5.
00665	Phosphorus-P	mg/l		
00530	Solids - Susp	mg/l		
00500	Solids (total) Diss	mg/l	1	2000.
00945	Sulfate	mg/l		
00625	TKN	mg/l		
00680	TOC	mg/l	1	71.
01092	Zinc	ug/l		
31616	Fecal coliform	100 ml		
	Barium	mg/l	1	200.
	Selenium	↓	1	1.9
	Silver	↓	1	<10
	T. Hd	mg/l		292

REPORTED
JB
JUL 6 1982
WATER LABORATORY
IND. STATE BD. OF HEALTH

WATER SAMPLE IDENTIFICATION SHEET

Sample Site: GARY LAND DEV. LAKE CO

Station Number: SOUTH

Sample Date: 7 (Mo. 11-12) 22 (Day 13-14) 82 (Yr. 15-16) AM/PM

Supervisor: SCHMIDT

Collector(s): BERNHUER, COPELAND

Delivered to lab: Mo. Day Yr. AM/PM

By: [signature]

Preservatives Added:

Kind	Lot No.	Amount
$K_2Cr_2O_7$		20 ml
HNO_3		[illegible]
H_2SO_4		[illegible]
NaOH		1

Sample Chlorinated _____ Not Chlorinated _____

	Field	Lab
No. of 1 Liter Plastic Bottles	5	5
No. of 2 Liter Plastic Bottles	1	1
No. of Bacteriological Bottles		
No. of Glass Jars or Bottles		
Total	6	6

Standard Procedure Followed: All Some None

NPDES Number (1-7) _____ Outfall (8-10) _____

17 (NPDES):
1. NPDES
2. SPC-15
3. WQ Study
4. Pollution complaint
5. Fish kill investigation

18 (Industry):
1. Industry
2. Semi-Public
3. Municipal
4. Federal
5. Public Water Supply
6. State operation
7. Other

19 (Sample Type):
1. Grab
2. 24-hour comp.
3. 8-hour comp.
4. 24-hour flow comp.
5. 8-hour flow comp.

20 Sample Interval

21:
0 - at outfall
1 - above outfall
2 - below outfall

22-26 Stream miles from outfall

LAB INFORMATION

Lab No. D2199 Date JUL 22 1982 8:30 (Mo. Day Yr. AM/PM)

Rec'd by: GB

Temp of samples when received: 4°C

Comments:

CODE	PARAMETERS	UNIT		LAB DATA
28-32 00410	Alkalinity Total $CaCO_3$	mg/l		34-41
00610	Ammonia-N	mg/l		
01002	Arsenic	ug/l	✓	2.0
00310	BOD_5	mg/l		
01027	Cadmium	ug/l	✓	<2.
00940	Chlorides	mg/l	✓	130.
01032	Chromium-Hex	ug/l		
01034	Chromium-Tot	ug/l	✓	<10.
00335	COD	mg/l	✓	44.
01042	Copper	ug/l		
00720	Cyanide-CN TOT	mg/l	✓	<0.005
00951	Fluoride	mg/l		
01045	Iron TOT	ug/l	✓	170.
01051	Lead	ug/l	✓	<10.
[illegible]	[illegible]	ug/l		
71900	Mercury	ug/l	✓	<0.1
01067	Nickel	ug/l		
00630	NO_2+NO_3-N	mg/l		
00550	Oil & Grease	mg/l		
00403	pH (lab)	S.U.	✓	1700 µmhos/cm
32730	Phenol	ug/l	✓	<5
00665	Phosphorus-P	mg/l		
00530	Solids - Susp	mg/l		
00500	Solids (total) TSS	mg/l	✓	1200.
00945	Sulfate	mg/l		
00625	TKN	mg/l		
00680	TOC	mg/l	✓	14.0
01092	Zinc	ug/l		
31616	Fecal coliform	100 ml		
	Barium	ug/l	✓	150.
	Selenium	↓	✓	4.0
	Silver	↓	✓	<10.
	Tot. Hard	mg/l	✓	600.

REPORTED
AUG 6 1982
WATER LABORATORY
IND. STATE BD. OF HEALTH

SUMMARY
GARY LAND DEVELOPMENT LANDFILL
(SW 133, OPP #45-2)
East of Cline Avenue at Gary Avenue

In January of 1970, the National Disposal Company of Barrington, Illinois, proposed a landfill at the above referenced location. At that time the proposal was denied on the grounds that sufficient impermeable cover soil was not available, the subsurface material was sand, the water table was two feet below the surface and the site was in the flood plain of the Grand Calumet River. This site was an abandoned sand pit which was full of water. The water was at the same elevation as the Calumet River and was most likely representative of the groundwater table in the area.

In October of 1972, Joe Tite, P.E., contacted the State and informed us that he had been hired by Rock Road Construction Company, an Illinois firm, to design a sanitary landfill in this old water-filled sand mine. Mr. Tite indicated that before he could proceed the pit would have to be dewatered and he requested State permission to discharge the water from the pit into the Calumet River. An analysis of the water in the pit showed it to be clean and on May 16, 1973, the Stream Pollution Control Board granted the new Gary Land Development Company permission to pump groundwater out of their pit into the Calumet River.

On May 31, 1973, the Gary Land Development Company submitted a sanitary landfill proposal which had been prepared by Joe Tite, P.E. The proposal called for an exterior perimeter drainage system, side walls of the sand pit to be sealed with clay, an interior leachate collecting system to be connected to the East Chicago Sanitary District sewers, daily cover with clay and no dumping of liquid or sludge wastes. Also, a system of monitoring wells was to be placed around the perimeter of the site. These plans were approved by the Stream Pollution Control Board on June 21, 1973.

By February of 1974, this site was still not dewatered and no appreciable amount of construction of the plans submitted in May of 1973 had yet taken place. In March of 1974 Joe Tite informed the State Board of Health that he was no longer involved with this site which prompted the Solid Waste Management Section to write to the Gary Land Development Company and ask for reassurances that this site was to be constructed in accordance with approval SW 133. On August 20, 1974, the City of Gary Sanitary District wrote to the Stream Pollution Control Board that the leachate collected at this site would be delivered by tank truck to their treatment plant. No mention was made on where the clay for cover would come from.

we have pit released Sept 73

Gary Land Development Landfill

On September 11, 1974, this site was inspected and indicated that all necessary construction was completed and the site should be given its operating permit. From subsequent inspections by different inspectors it was determined that the two separate collection systems, one for dewatering and one for leachate collection, were never constructed and that leachate is being pumped into the Calumet River instead of being trucked to the Gary Sewage Treatment Plant. Also, the sides of the sand pit have not been adequately lined with clay, and daily cover when applied is with sand not clay as specified.

On January 30, 1975, this site was inspected and liquid wastes were observed to have been deposited. From January 30, 1975, until the present, every inspection of this site has noted that hazardous, liquid and sludge wastes are being dumped. The manager of this site, Larry Hagan, has been cautioned about accepting these wastes without Stream Pollution Control Board approval yet he continues to accept them. On November 17, 1975, a meeting was held between Mr. Hagan and members of the Indiana State Board of Health, Solid Waste Management Section, at which time Mr. Hagan was ordered to stop taking unauthorized hazardous waste. Also, he was told to put in monitoring wells and to improve his covering of refuse. Subsequent inspections revealed no improvement in the operation and on January 12, 1976, Gary Land Development Company was ordered by letter to cease all dumping of liquid sludge and hazardous waste immediately. On February 20, 1976, a violation letter was sent indicating problems with leachate, daily cover, blowing paper, and a need for monitoring wells.

This site is presently accepting liquid, sludge, and hazardous waste in violation of SPC-18, Chapter V. Also our lab analysis of leachate samples taken on August 27, 1976, indicate that significant amounts of heavy metals and oils are being pumped into the Grand Calumet River.

On November 5, 1976, a violation letter was sent citing this site for violation of the Environmental Management Act, due to its discharge of leachate from the site into the river. Mr. Hagen was to advise the staff within 15 days of the date of the letter as to what measures would be taken to correct the violation.

On December 2, 1976, two staff members met with Mr. Hagen and asked what he was going to do about his discharge. He stated he had contacted his lawyer and was sending a complaint to the Governor and until he heard from his lawyer he was not going to do anything with it. On December 14, 1976, a letter from Oral Hert was sent to Mr. Hagen citing his continued violation and stating his operating permit would not be renewed if the discharge was not discontinued. Once again Mr. Hagen was told to advise the staff within 15 days of the date of the letter as to what measures would be taken to correct this violation. To date no reply has been received.

Gary Land Development Landfill

On December 28, 1976, four staff members, the Solid Waste Management Section Chief, and the Director of the Division of Sanitary Engineering inspected this site. Several pictures were taken.

Staff recommends that a hearing be scheduled through the Stream Pollution Control Board.

BHP/sjk
1/18/77

WATER SAMPLE IDENTIFICATION SHEET

Sample Site [illegible]

Station Number [illegible]

Sample Date 7 [illegible] 90 3:30 (Mo. 11-12, Day 13-14, Yr. 15-16, AM/PM)

Supervisor [illegible]

Collector(s) [illegible]

Delivered to lab 7 [illegible] 90 [illegible] (Mo., Day, Yr., AM/PM)

By [illegible]

Preservatives Added:	Kind	Lot No.	Amount
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]

Sample Chlorinated _____ Not Chlorinated ✓

	Field	Lab
No. of 1 Liter Plastic Bottles		
No. of 2 Liter Plastic Bottles	4	4
No. of Bacteriological Bottles		
No. of Glass Jars or Bottles		
Total	4	4

Standard Procedure Followed All Some None

NPDES Number _____ (1-7) Outfall _____ (8-10)

17 (_____)
1. NPDES
2. SPC-15
3. WQ Study
4. Pollution complaint
5. Fish kill investigation

18 (_____)
1. Industry
2. Semi-Public
3. Municipal
4. Federal
5. Public Water Supply
6. State operation
7. Other

19 (_____) Sample Type
1. Grab
2. 24-hour comp.
3. 8-hour comp.
4. 24-hour flow comp.
5. 8-hour flow comp.

20 (_____) Sample Interval

21 (_____)
0 - at outfall
1 - above outfall
2 - below outfall

22-26 (_____) Stream miles from outfall

LAB INFORMATION

Lab No. 2408 Date JUL 21 1990 9:35 (Mo. Day Yr. AM/PM)

Rec'd by [illegible]

Temp of samples when received _____

Comments:

CODE	PARAMETERS	UNIT		LAB DATA
28-32 00410	Alkalinity Total $CaCO_3$	mg/l		34-41
00610	Ammonia-N	mg/l		
01002	Arsenic	ug/l	✓	4.
00310	BOD_5	mg/l		
01027	Cadmium	ug/l	✓	<2.
00940	Chlorides	mg/l	✓	73.
01032	Chromium-Hex	ug/l	✓	<10.
01034	Chromium-Tot	ug/l		
00335	COD	mg/l	✓	34.
01042	Copper	ug/l		
00720	Cyanide-CN	mg/l		
00951	Fluoride	mg/l	✓	0.5
01045	Iron	ug/l	✓	41,200.
01051	Lead	ug/l	✓	<20.
01055	Manganese	ug/l		
71900	Mercury	ug/l	✓	0.1
01067	Nickel	ug/l		
00630	NO_2+NO_3-N	mg/l	✓	0.1
00550	Oil & Grease	mg/l		
00403	pH (lab)	S.U.		
32730	Phenol	ug/l		
00665	Phosphorus-P	mg/l		
00530	Solids - Susp	mg/l		
00500	Solids (total)	mg/l		
00945	Sulfate	mg/l		
00625	TKN	mg/l		
00680	TOC	mg/l	✓	10.9
01092	Zinc	ug/l		
31616	Fecal coliform	100 ml		
	TDS ppm		✓	800.
	Tot. Hd. ppm ($CaCO_3$)		✓	404.
	As ppb		✓	<10.
	Ba ppb		✓	90.
	[illegible] ppb			

REPORTED
AUG 20 1990 [illegible]
WATER LABORATORY
IND. STATE BD. OF HEALTH

WATER SAMPLE IDENTIFICATION SHEET

Sample Site: Gas Development Co
Lake Co

Station Number: South Well

Sample Date: 7 (Mo. 11-12) 17 (Day 13-14) 80 (Yr. 15-16) 3:30 AM/PM

Supervisor: Karen Schmidt

Collector(s): Dave Strunk

Delivered to lab: 7 (Mo.) 21 (Day) 80 (Yr.) 9:45 AM/PM

By: Dave Strunk

Preservatives Added:

Kind	Lot No.	Amount
HNO3	6/80	5 ml
[illegible]	[illegible]	[illegible]
H2SO4	[illegible]	5 [illegible]

Sample Chlorinated _____ Not Chlorinated ✓

	Field	Lab
No. of 1 Liter Plastic Bottles		
No. of 2 Liter Plastic Bottles	4	4
No. of Bacteriological Bottles		
No. of Glass Jars or Bottles		
Total	4	4

Standard Procedure Followed: All Some None

NPDES Number _____ (1-7) Outfall _____ (8-10)

17:
1. NPDES
2. SPC-15
3. WQ Study
4. Pollution complaint
5. Fish kill investigation

18:
1. Industry
2. Semi-Public
3. Municipal
4. Federal
5. Public Water Supply
6. State operation
7. Other

19 Sample Type:
1. Grab
2. 24-hour comp.
3. 8-hour comp.
4. 24-hour flow comp.
5. 8-hour flow comp.

20 Sample Interval

21:
0 - at outfall
1 - above outfall
2 - below outfall

22-26 Stream miles from outfall

LAB INFORMATION

Lab No. 2407 Date JUL 21 1980 9:30 (Mo. Day Yr. AM/PM)

Rec'd by: [illegible]

Temp of samples when received _____

Comments:

CODE	PARAMETERS	UNIT		LAB DATA
28-32 00410	Alkalinity Total $CaCO_3$	mg/l		34-41
00610	Ammonia-N	mg/l		
01002	Arsenic	ug/l	✓	1.
00310	BOD_5	mg/l		
01027	Cadmium	ug/l	✓	<2.
00940	Chlorides	mg/l	✓	840.
01032	Chromium-Hex	ug/l	✓	<10.
01034	Chromium-Tot	ug/l		
00335	COD	mg/l	✓	49.
01042	Copper	ug/l		
00720	Cyanide-CN	mg/l		
00951	Fluoride	mg/l	✓	1.5
01045	Iron	ug/l	✓	650.
01051	Lead	ug/l	✓	<20
01055	Manganese	ug/l		
71900	Mercury	ug/l	✓	0.1
01067	Nickel	ug/l		
00630	NO_2+NO_3-N	mg/l	✓	0.1
00550	Oil & Grease	mg/l		
00403	pH (lab)	S.U.		
32730	Phenol	ug/l		
00665	Phosphorus-P	mg/l		
00530	Solids - Susp	mg/l		
00500	Solids (total)	mg/l		
00945	Sulfate	mg/l		
00625	TKN	mg/l		
00680	TOC	mg/l	✓	29.4
01092	Zinc	ug/l		
31616	Fecal coliform	100 ml		
	TDS ppm		✓	3300.
	Tot. Hardness ppm (CaCO3)		✓	1048.
	Hg ppb		✓	10.
	Ba ppb		✓	100.

REPORTED
AUG 20 1980
WATER LABORATORY
IND. STATE BD. OF HEALTH

WATER AND WASTE SAMPLING FIELD DATA
Solid Waste Management Section

Facility and/or Project GLF ~~DISPOSAL SITE~~ DEVELOPING

Location GEE LIE + CLIFF AVE.

Collector(s) DEEK SCHUK

Sampling Date JULY 17, 1990 No. of Stations 4

Reasons for Sampling: Annual ✓ Complaint _____

Data Collection _____ Enforcement _____

Note: Use station numbers for items listed below.

SAMPLE SOURCES:

Well(s)

Monitoring AFTER RAIN - SOUTH WELL

Treated Supply _____

Untreated Supply _____

Stream

Upstream _____

Downstream _____

Other _____

_____

Pond _____

Outfall _____

Marsh _____

Spring or Seep _____

Leachate _____

Sludge _____

Type(s) _____

Containerized Waste _____

Type(s) _____

Soil _____

Other _____

SAMPLING METHODS:

Pump _____; Type _____

Bailer ✓; Type PVC PIPE

Grab _____; Bottle types _____

Auger _____; Sample depth(s) _____

Flushed casing prior to sampling YES

Filtered: Field ✓ Lab ____ Not filtered ____

Preserved: Field ✓ Lab ____ Not preserved ____

Refrigeration in field No Blank prepared NONE

Samples split with NO ONE (please complete)

Photographs attached NONE

Sample Description:

Sample No.	Color	Odor	Appearance	Other
N.E.	ORANGE/BLACK	VERY MUCH!	DARK	
S.W.	GRAY, BLACK	YES	DARK MUDDY	

PRECIPITATION DATA:

Rain ____ Snowmelt ____ Recent past (date) ____

Snow ____ During sampling ____ Not applicable ✓

INFLUENTIAL FACTORS:

1) Proximity to other potential pollution sources (describe) THE S. WELL IS NEXT TO THE RIVER, FOR MANY YEARS REGULAR SEWER. THINK THAT THE WATER BETWEEN THE LIGHT SLUDGE WATER FROM THE SEWER WENT TO THE

2) Well casing condition (note missing caps, casing cracks, condition of annular seals, etc.) NOTE: THE N.E. IS A WATER WELL BUT HAS NO CAP.

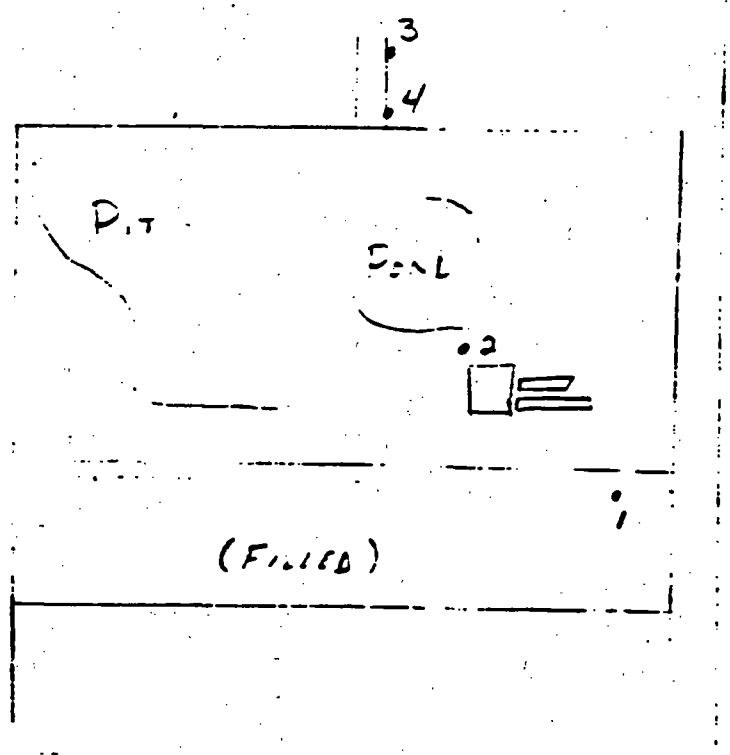
3) Ponded water around casing(s) NO

4) Water level(s) in casing(s) prior to flushing N. Side = 11.7', S. WELL = 11.1'

5) Well depth(s) N Bank = 20.9', S = 16.5

6) Other

In the space below, accurately locate sampling stations on a sketch map. Include a north arrow, prominent landmarks, flow directions, potential pollution sources, and any other pertinent information.



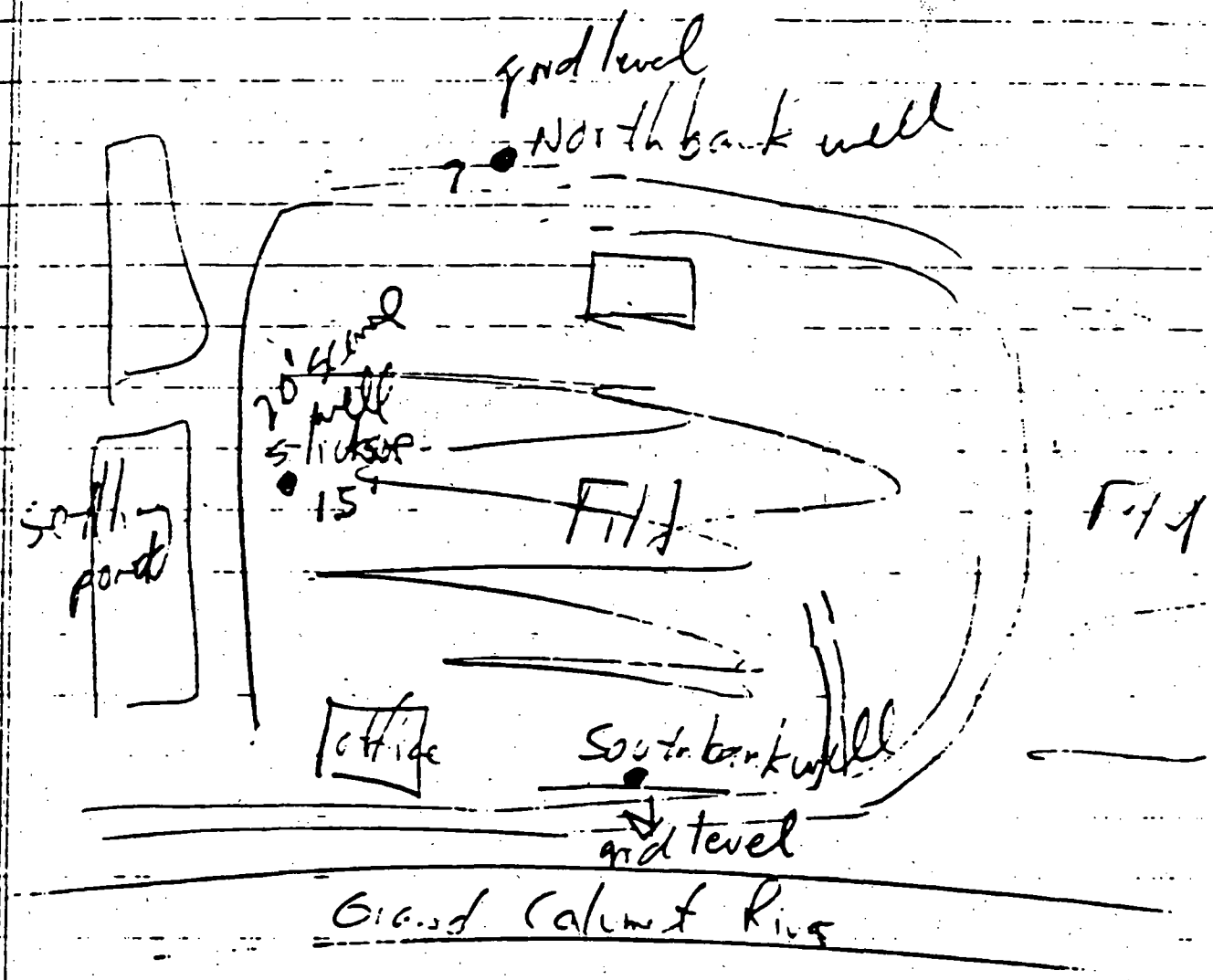
REMARKS:

Delivered to Lab: 7 (Month) 17 (Day) [illegible] (Year) [illegible] (Time) A.M. P.M.

By: (Name) [illegible] (Title) SUMMER STUDENTS

(Division) [illegible] ENGINEERING

Gary Land Development
well location



SM

Indiana State Board of Health
Division of Land Pollution Control
Solid Waste Management Branch
Solid Waste Facility Inspection Report

DATE 8-1-84	TIME 9:00 AM	COUNTY Lake
FACILITY Gary Land Development		CONSTRUCTION PERMIT (Yes)
LOCATION Cline Ave & Gary Ave		OPERATING PERMIT (Yes #) 45 No
TYPE OF OPERATION (Landfill) Transfer Facility Resource Recovery Solid Fill Site Other		INSPECTED BY Chris Oppy

GENERAL STANDARDS
1. ON SITE ROADS
2. EMPLOYEE FACILITIES
*3. ANIMAL FEEDING

WATER QUALITY
4. MONITORING WELL SAMPLING
5. SURFACE DRAINAGE
*6. REFUSE PLACED IN WATER
7. LEACHATE ON SITE
*8. LEACHATE OFF SITE

AIR QUALITY
*9. OPEN BURNING

AESTHETICS
10. BLOWING LITTER
11. LIMITED ACCESS
12. REFUSE CONTAINERS
13. ENTRANCE SIGN
14. SALVAGE MATERIALS

VECTORS
15. VECTORS

SAFETY
16. ROLL BARS & FIRE EXTING.
17. PROVISIONS TO EXTINGUISH REFUSE FIRES
18. SCAVENGING
19. COMMUNICATIONS
20. TRAFFIC PATTERNS

COVER APPLICATION
21. SPREADING & COMPACTING
*22. DAILY COVER
23. FINAL COVER
24. FINAL GRADING & SEEDING

HAZARDOUS & SPECIAL WASTE
*25. UNAPPROVED HAZARDOUS WASTE
*26. IMPROPER HAZARDOUS WASTE DISPOSAL
27. BULKY WASTE
28. DEAD ANIMALS

EQUIPMENT & RECORDS
29. OPERATING EQUIPMENT
30. APPROVED PLANS
*31. DEVIATION FROM APPROVED PLANS

PROCESSING FACILITIES
*32. HOUSEKEEPING
*33. ENCLOSED OVER-NIGHT STORAGE

ACCEPTABLE [X]
UNACCEPTABLE [ ]

The items circled above identify violation(s) of Rule 320 IAC 5 which must be corrected by the next inspection or sooner if specified in writing.

*Circled asterisk violations require immediate correction and results in an unacceptable rating.

COMMENTS: Weather is dry today. Site looks good today. Final cover for previous area is well applied, with additional cover to be added later.

Present working face area has satisfactory plans regarding fall plans and it is presently in fair shape, i.e., sufficient cover and good compaction.

No leachate onsite today.

Signed by: J. Hogan Jr. (Responsible Party) _____ (Operator)

SM 07

Indiana State Board of Health
Division of Land Pollution Control
Solid Waste Management Branch
Solid Waste Facility Inspection Report

DATE 5-24-84	TIME 1:17 PM	COUNTY Lake
FACILITY Gary Land Development		CONSTRUCTION PERMIT (Yes) No
LOCATION Gary Ave & Cline		OPERATING PERMIT (Yes) 45-2 No
TYPE OF OPERATION: (Landfill) Transfer Facility Resource Recovery Solid Fill Site Other _____		INSPECTED BY Chris Oppy & Stu Miller

GENERAL STANDARDS
1. ON-SITE ROADS
2. EMPLOYEE FACILITIES
*3. ANIMAL FEEDING

WATER QUALITY
4. MONITORING WELL SAMPLING
5. SURFACE DRAINAGE
*6. REFUSE PLACED IN WATER
(7) LEACHATE ON SITE
*8. LEACHATE OFF SITE

AIR QUALITY
*9. OPEN BURNING

AESTHETICS
10. BLOWING LITTER
11. LIMITED ACCESS
12. REFUSE CONTAINERS
13. ENTRANCE SIGN
14. SALVAGE MATERIALS

VECTORS
15. VECTORS

SAFETY
16. ROLL BARS & FIRE EXTING.
17. PROVISIONS TO EXTINGUISH REFUSE FIRES
18. SCAVENGING
19. COMMUNICATIONS
20. TRAFFIC PATTERNS

COVER APPLICATION
21. SPREADING & COMPACTING
*22. DAILY COVER
23. FINAL COVER
24. FINAL GRADING & SEEDING

HAZARDOUS & SPECIAL WASTE
*25. UNAPPROVED HAZARDOUS WASTE
*26. IMPROPER HAZARDOUS WASTE DISPOSAL

27. BULKY WASTE
28. DEAD ANIMALS

EQUIPMENT & RECORDS
29. OPERATING EQUIPMENT
30. APPROVED PLANS
*31. DEVIATION FROM APPROVED PLANS

PROCESSING FACILITIES
*32. HOUSEKEEPING
*33. ENCLOSED OVER-NIGHT STORAGE

ACCEPTABLE [X]
UNACCEPTABLE [ ]

The items circled above identify violation(s) of Rule 320 IAC 5 which must be corrected by the next inspection or sooner if specified in writing.

*Circled asterisk violations require immediate correction and results in an unacceptable rating.

COMMENTS: #7 Leachate on north end & in water. A significant amount of area needs more dress cover & more conscious attention should be given to the daily cover of the current working face.

Received by: L. Hayes Jr
Responsible Party

_____
Operator

FEB 08 1984

FEB 13

John M. Kyle III
Barnes and Thornburg
1313 Merchants Bank Building
Indianapolis, Indiana 46204

Re: Gary Development Landfill
Gary, Indiana

Dear Mr. Kyle:

Thank you for your letter of October 7, 1983, requesting the removal of Gary Development Landfill from the Federal hazardous waste management system. Based upon the information you have supplied, plus other information available to this office, the facility is required to have a Resource Conservation and Recovery Act (RCRA) permit, and may not be withdrawn from the hazardous waste system.

Your request is based upon the quantity of hazardous wastes disposed of at the landfill. RCRA regulations do not provide for waivers of closure or post-closure requirements based upon the quantity of wastes handled. Furthermore, we have learned that your statements concerning the wastes that Gary Development has accepted from American Chemical Service, Inc. are inaccurate in several respects. A recent inspection of American Chemical Service revealed that 33 shipments of hazardous waste, labelled F005, were sent by manifest to Gary Development in 1981. Each shipment was approximately 2750 gallons. In addition, we were informed that a number of shipments of the same material were erroneously sent without manifests from November 19, 1980, until early 1981. This contradicts your statement that only four to six loads were received from American Chemical Service.

The hazardous waste number F005 represents certain non-halogenated solvents which are listed as hazardous wastes for the properties of ignitability and toxicity. Our understanding of the process which generates the wastes leads us to believe that any of the hazardous waste types handled by American Chemical Service might be present in the wastes sent to Gary Development. This includes hazardous waste numbers F001, F002, F005, U147, U031, U112, U002, U154, F001 and F003. The first three wastes in this list are hazardous because of their toxicity. American Chemical service also handles paint waste, which may be hazardous due to heavy metal toxicity. Therefore, we find your assertion that American Chemical Service waste is only ignitable to be invalid.

Finally, we discovered that the American Chemical Service wastes were not mixed with sand to eliminate ignitability, as your January 24, 1983, letter to George Garland states. The co-mixing of sand and wastes did not begin until late 1981 or early 1982.

With respect to your question concerning the applicability of 40 CFR Parts 264 and 265 to the activities performed by Gary Development Landfill, please find enclosed a copy of the November 22, 1983, Federal Register. This amendment clarifies the applicability of the hazardous waste regulations to existing facilities which fail to qualify for interim status, such as Gary Development. On page 52719, it is stated that "EPA has both the statutory and regulatory authority to apply either the Part 264 general permitting standards or the Part 265 interim status standards to existing facilities which have failed to qualify for interim status." The document sets forth an amendment to 40 CFR §265.1 which establishes that Part 265 is the appropriate set of standards applicable to facilities such as Gary Development Landfill, until a permit is issued. Since the State of Indiana has received Phase I interim authorization, the Indiana State Board of Health (ISBH) is responsible for administering the interim status standards in lieu of the Federal government. Indiana has clarified the applicability issue by deleting §265.1(b) in their adoption of Part 265, and inserting language which makes the standards applicable to all hazardous waste facilities regardless of permit status.

Factors which ISBH may consider in approving any closure and post-closure plans submitted by the landfill do include the quantity, types of waste, and methods of management. Because of the landfill's repeated ratings of "unacceptable operation" in State inspections, its location in the Grand Calument River floodplain, and the actual quantity and nature of American Chemical Service waste disposed of there, we believe that proper closure will involve a design with numerous protective measures.

We have considered the above factors, plus the Agreed Order reached between the Environmental Management Board and Gary Development in early 1983, and have concluded that it is not in the public interest for Gary Development Landfill to be issued an Interim Status Compliance Letter for continued hazardous waste operation. Since the Landfill does not have interim status or a permit, closure and post-closure are required.

In summary, (1) Gary Development Landfill is in violation of RCRA Section 3005, plus 40 CFR §§270.2(c), 270.10(a) and 124.3(a), for disposal of hazardous wastes without a permit; (2) the landfill is subject to regulation under 320 Indiana Administrative Code, Article 4; and (3) the landfill must undergo closure pursuant to these regulations to avoid enforcement action by this office.

Please contact Mr. Richard Shandross, at (312) 886-0986, if you have any questions about this matter.

Sincerely yours,

Karl J. Klepitsch, Jr., Chief
Waste Management Branch

Enclosure

cc: Guinn Doyle, ISBH
~~Jim~~ Traylor, ISBH GET 2/13
Gary Development Landfill

STATE BOARD OF HEALTH

INDIANAPOLIS

OFFICE MEMORANDUM

DATE: January 23, 1984

TO: Gary Development Landfill File
Lake County

THRU: Dan Magoun 1/23/84

FROM: Stuart Miller SM 1-23-84
Division of Land Pollution Control

SUBJECT: Meeting on January 5, 1984

On January 5, 1984, Mr. George Oliver, Mr. Bruce Palin, Mr. Mathew Scherschel of the Attorney General's Office, and myself met with Mr. Larry Hagen and his attorney, Mr. John Kyle III, at the Indiana State Board of Health Building. The following is a list of the discussions:

1. Over the July 4th weekend, the Gary area received seven inches of rain in a two-hour period. As a result, the Grand Calumet rose above the 100-year flood stage and spilled over the road and into the Gary Development Landfill site. It is estimated by Mr. Hagen that 100 million gallons of water infiltrated his site. Also, a lot of sediment was added to the site. Mr. Hagen lost both cranes and many pumps. On July 14, Mr. Hagen went to Louisville to buy a crane. He bought one for $137,000 and had it shipped to his site. Due to the bolts being cut on the crane, Mr. Hagen had to order new parts and the crane was finally operative by the end of August. Out-of-pocket expenses are estimated at $300,000.

2. My inspection of August 25, 1983, documented the Gary Development Landfill to be unacceptable. The water had still not been pumped out by this date. They requested that this inspection be rescinded and not used in evaluating a renewal application.

3. My inspection of October 13, 1983, documented the Gary Development Landfill to be unacceptable. The water had still not been pumped out by this date, although progress had been made. They also requested that this inspection be rescinded and not used in evaluating a renewal application.

4. We discussed the soil borings that were required on the west wall as specified in the Consent Decree. Water is standing in this area and it is too wet to do borings. They suggested that Vulcan Materials is the cause of the water problem. They also contend that due to the manner in which the wall was constructed, the borings won't tell us anything.

5. We discussed the special waste revocations recently sent. They do not believe that there was just cause to revoke these approvals. Also, it would make Gary Land Development go bankrupt. They indicated that they needed these approvals.

6. We discussed the Gary Open Dump and what they thought could have been done in this matter. Mr. Mathew Scherschel was going to look into this to see if anything else can be done.

7. We briefly discussed the Samocki hole and they indicated that material from J & L Steel was being deposited here.

8. We also briefly discussed what needed to be done to properly close the site. We indicated that Rule 320 IAC 5 outlined requirements for closure.

SCM/tr
cc: Mr. George Oliver
Mr. Bruce Palin

1/20/84

LAND POLLUTION CONTROL SAMPLE SHEET

Page 1 of 1

Sample I.D. MB North Control No. Cm
Sample Location
GREY AND SEDIMENT

Site Contact GATEY HAGAN
Sample Date 7 / 21 / 83 1:25 a.m. p.m.
Collector(s) Beauver + Legland
Delivered to Lab 7 / 21 / 83 2:30 a.m. p.m.

By(Signature) [signature]

CONTAINERS	Field	Lab	Solv Rinsed
No. 1 L Plastic Bottles	5	5	
No. Glass Bottles			
No. Glass Jars			
No. Purgeable Vials			
TOTAL	5	5	

PRESERVATIVES USED		Kind	Lot No.	Amount
	*	50% H2SO4	7-23-4	2 ml.
Sample Iced	*	HNO3 5	7-23-21	5 ml.
	*	50% NaOH	1-23-15	1 ml.
No Preservative Used	*	Hg pres.	6 23-2	20 ml.
	*			

For Enforcement ? Yes (No)

SAMPLE TYPE(Circle One)

Well	(Mon. Well)	Ash	Indust. Waste	Solid
Creek	Leachate	Soil	Waste Pile	Fluid
Ditch	Oil	Sludge	Drummed Waste	Misc.
Lagoon	Solvent	Sand	Field Blank	

PROGRAM AREA
RCRA CERCLA Solid Waste (Summer Monitor)

Results Requested By ___/___/___

Handling precautions? Yes No
If yes, why ?

Approximate Concentration(Worst Case)
(less than 10 ppm) 1000ppm 5 % greater than 15 %

LAB INFORMATION
Lab No. T0347 Date 7/21/83 2:30 a.m. (p.m.)

Rec'd By [signature]

Code to: TC (JH) Other

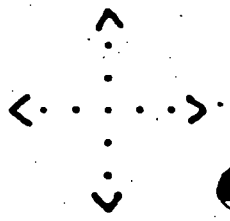
Comments:
water 16'
well 23.3'

PARAMETERS	UNITS			RESULTS
Arsenic	ug/l	/		1.5
Barium	ug/l	/		160.
Cadmium	ug/l	/		<2.
Chromium-Total	ug/l	/		<10.
Lead	ug/l	/		<10.
Mercury	ug/l	/		<0.1
Selenium	ug/l	/		<0.2
Silver	ug/l	/		<10.
Nickel	ug/l	/		<10.
Iron-Total	ug/l	/		8500.
Manganese	ug/l	/		240.
Sodium	mg/l	/		190
Chlorides	mg/l	/		130.
Sulfates	mg/l	/		87.
Phenol	ug/l	/		<5.
Cyanide-Total	ug/l	/		<5.
Cyanide-Free	mg/l			
COD	mg/l			
TOC	mg/l	/		9.2
TOX	mg/l			
pH	S.U.	/		7.4
Sp. Cond.	umho/cm	/		1550.
Solids-Total	mg/l			
Solids-Dissolved	mg/l	/		850.
Flash Point	°F			
PCB	ug/l			
Volatile Orgs.				see organics page
Extractable Orgs.				see organics page

Sampling Methods: (grab) composite) Bailed, 8 gal purged

Sampling Notes: No cap → coating of shingle + a block of wood used as ca
water has a sulfice odor, west of well large area of ponded H_2O

MAP:



SAMPLE PRESERVATION

PARAMETERS	PRESERVATIVE	CONTAINER
All samples should be iced but only the water samples should be preserved.		
Metals	5 ml HNO_3/liter + Ice	1 L Plastic
Mercury	20 ml (2.5% $K_2Cr_2O_7$ in 25% HNO_3)/liter + Ice	1 L Plastic
Cyanide-Total, Free	1 ml 50% NaOH/liter + Ice	1 L Plastic
COD, TOC, Nitrates, Ammon., Phos., TKN	2 ml 50% H_2SO_4/liter + Ice	1 L Plastic
Phenol	2 ml 50% H_2SO_4/liter + Ice	1 L Plastic
Solids, pH, Chlorides Spec. Cond.	Ice	1 L Plastic
PCB, Extractable Organics	Ice	Solv Rinsed Quart Jar
Purgeable Organics, TOX	Ice	Purgeable Vials
Porous Samples	Ice	Glass

SAMPLE RECEIPT

Split Samples Requested: Yes (No)

Split Samples Accepted: Yes (No)

(Signature): [illegible]

Send Results To:
Name: GARY DEVELOPMENT CO INC.
Address: 474 N. CLINE AVE
P.O. BOX 6056 GARY IND.
46406

Comments:

LPC Rep(Signature):

LAND POLLUTION CONTROL SAMPLE SHEET

Sample I.D. mw South Control No. 5m
Sample Location

[illegible] LAND DEVELOPMENT

Site Contact Larry Hann
Sample Date 7 / 20 / 83 1:45 a.m. p.m.
Collector(s) Berdauer + Copeland
Delivered to Lab 7 / 21 / 83 2:30 a.m. p.m.

By(Signature) [signature]

CONTAINERS	Field	Lab	Solv Rinsed
No. 1 L Plastic Bottles	5	5	
No. Glass Bottles			
No. Glass Jars			
No. Purgeable Vials			
TOTAL	5	5	

PRESERVATIVES USED		Kind	Lot No.	Amount
	*	50% H2SO4	7-23 4	2 ml.
Sample Iced	*	HNO3	7-23-2	5 ml.
	*	50% NaOH	1-23-19	1 ml.
No Preservative Used	*	Hg pres.	7-23 4	20 ml.
	*			

For Enforcement ? Yes No

SAMPLE TYPE(Circle One)

Well	Mon. Well	Ash	Indust. Waste	Solid
Creek	Leachate	Soil	Waste Pile	Fluid
Ditch	Oil	Sludge	Drummed Waste	Misc.
Lagoon	Solvent	Sand	Field Blank	

PROGRAM AREA
RCRA CERCLA Solid Waste Summer Monitor

Results Requested By ___/___/___

Handling precautions? Yes No
If yes, why ?

Approximate Concentration(Worst Case)
less than 10 ppm 1000ppm 5 % greater than 15 %

LAB INFORMATION

Lab No. T0348 Date 7 / 21 / 83 2:30 a.m. p.m.

Rec'd By [signature]

Code to: TC TH Other

Comments:
water 40"
well
stick up 0"

Arsenic	ug/l	/		0.7
Barium	ug/l	/		110.
Cadmium	ug/l	/		< 2.
Chromium-Total	ug/l	/		< 10.
Lead	ug/l	/		< 10.
Mercury	ug/l	/		< 0.1
Selenium	ug/l	/		0.3
Silver	ug/l	/		10.
Nickel	ug/l	/		< 10.
Iron-Total	ug/l	/		520.
Manganese	ug/l	/		390.
Sodium	mg/l	/		79.
Chlorides	mg/l	/		130.
Sulfates	mg/l	/		870.
Phenol	ug/l	/		< 5.
Cyanide-Total	ug/l	/		17.
Cyanide-Free	ug/l			
COD	mg/l			
TOC	mg/l	/		12.5
TOX	mg/l			
pH	S.U.	/		7.0
Sp. Cond.	umho/cm			2150.
Solids-Total	mg/l			
Solids-Dissolved	mg/l	/		1700.
Flash Point	°F			
PCB	ug/l			
Volatile Orgs.				see organics page
Extractable Orgs.				see organics page

Sampling Methods: (grab composite) Bailed, 8gal, purged

Sampling Notes: No cap - 5gal bucket used as cap!

MAP:

SAMPLE PRESERVATION

PARAMETERS	PRESERVATIVE	CONTAINER
All samples should be iced but only the water samples should be preserved.		
Metals	5 ml HNO3/liter + Ice	1 L Plastic
Mercury	20 ml (2.5% K2Cr2O7 in 25% HNO3)/liter + Ice	1 L Plastic
Cyanide-Total, Free	1 ml 50% NaOH/liter + Ice	1 L Plastic
COD, TOC, Nitrates, Ammon., Phos., TKN	2 ml 50% H2SO4/liter + Ice	1 L Plastic
Phenol	2 ml 50% H2SO4/liter + Ice	1 L Plastic
Solids, pH, Chlorides Spec. Cond.	Ice	1 L Plastic
GB, Extractable Organics	Ice	Solv Rinsed Quart Jar
Purgeable Organics, TOX	Ice	Purgeable Vials
Pesticides Samples	Ice	Glass

SAMPLE RECEIPT

Split Samples Requested: Yes (No)

Split Samples Accepted: Yes (No)

(Signature): Terry Haggin TK

Send Results To:

Name:

Address:

Comments:

LPC Rep(Signature): [signature]

GULF COAST LABORATORIES, INC.
2417 Bond St., Park Forest South, Illinois 60466
Phones (312) 534-4200 (219) 885-7077 (815) 723-753

ANALYTICAL REPORT

TO: Gary Development
P. O. 6056
Gary, Indiana 46406

ATTN: Mr. Larry Hagen

DATE: February 24, 1983

RE: Monitoring Well Analysis
Sample Date: 2/08/83
North Well
GCL# 35969

PARAMETERS	RESULTS
Chloride	83 mg/l
COD	45 mg/l
Hardness	290 mg/l
Total Iron	1.1 mg/l
pH	7.2
Total Dissolved Solids	1,115 mg/l

MAR 7 2 35 PM '83
DIV. OF LAND POLLUTION CONTROL
STATE BOARD OF HEALTH

Approved Donald Lapple Analyst _____ Date 2/24/8

GULF COAST LABORATORIES, INC.
2417 Bond St., Park Forest South, Illinois 60466
Phones (312) 534-5200 (218) 885-7077 (815) 723-75:

ANALYTICAL REPORT

TO: Gary Development
P. O. 6056
Gary, Indiana 46406

ATTN: Mr. Larry Hagen

DATE: February 24, 1983

RE: Monitoring Well Analysis
Sample Date: 2/08/83
South Well
GCL# 35970

PARAMETERS	RESULTS
Chloride	245 mg/l
COD	630 mg/l
Hardness	1,060 mg/l
Total Iron	0.3 mg/l
pH	7.2
Total Dissolved Solids	1,870 mg/l

Analyst Donald Spigle Date 2/24/8

GULF COAST LABORATORIES, INC.
2417 Bond St., Park Forest South, Illinois 60466
Phones (312) 534-5200 (219) 885-7077 (81[illegible]) 723-75[illegible]

ANALYTICAL REPORT

TO: Gary Development
P. O. 6056
Gary, Indiana 46406

ATTN: Mr. Larry Hagen

DATE: February 24, 1983

RE: Monitoring Well Analysis
Sample Date: 2/08/83
West Well
GCL# 35971

PARAMETERS	RESULTS
Chloride	325 mg/l
COD	40 mg/l
Hardness	320 mg/l
Total Iron	0.3 mg/l
pH	6.8
Total Dissolved Solids	1,070 mg/l

Approved _____ Analyst _____ Date _____

STATE OF INDIANA)
) SS:
COUNTY OF MARION)

BEFORE THE ENVIRONMENTAL MANAGEMENT BOARD OF THE STATE OF INDIANA

IN THE MATTER OF GARY DEVELOPMENT, INC., Petitioner,	)	
v.	)	CAUSE NO. N-53
THE ENVIRONMENTAL MANAGEMENT BOARD OF THE STATE OF INDIANA, Respondent.	)	

SETTLEMENT AGREEMENT AND RECOMMENDED AGREED ORDER

Comes now Petitioner, Gary Development, Inc., by counsel and by Larry Hagen, Vice President and General Manager; and comes now Respondent, the Indiana Environmental Management Board ("EMB"), by Linley Pearson, Attorney General, by Mathew Scherschel, Deputy Attorney General. The parties show the Hearing Officer that they have resolved their differences and ask the Hearing Officer to recommend an order to EMB in accordance with the terms and conditions set forth in Part II below.

I. HISTORY AND BACKGROUND

In early 1973, Petitioner began to explore developing a sanitary landfill in a mined-out, water-filled, sand pit in Gary, Indiana (hereafter called the "site"). On May 15, 1973, The Indiana Stream Pollution Control Board ("SPCB") approved Petitioner's proposal to dewater the sand pit. On June 19, 1973, SPCB granted Petitioner Construction Permit SW133, thereby allowing preparatory construction work for a sanitary landfill to begin.

On August 29, 1974, the State conducted its final inspection of the site which led to SPCB's granting final approval to Petitioner to commence sanitary landfill operations. The landfill began accepting solid waste for disposal in September, 1974. On February 20, 1975, SPCB sent Petitioner its Operating Permit, No. 45-2.

On May 20, 1980, SPCB approved an Agreed Order negotiated between Petitioner and SPCB staff. This Order required that Petitioner submit within 180 days of May 20, 1980, an application for a modification of its original construction permit. This application was timely submitted to SPCB on November 14, 1980.

On February 16, 1982, the Indiana Environmental Management Board ("EMB": in the interim, EMB replaced SPCB as the Indiana agency responsible for landfill permits) notified Petitioner by two nearly identical letters (hereafter called the "February 16, 1982 letter"), indicating that its Operating Permit No. 45-2 had been renewed and that its revised construction plans submitted November 14, 1980, had been approved, both subject to nine conditions. Petitioner thereafter filed a petition for hearing, contesting the imposition of these nine conditions.

Since that time the parties have negotiated the agreement set forth in Part II below, resolving the issues in dispute. The parties request that the Hearing Officer recommend that EMB enter the provisions of Part II below as an Agreed Order in Cause No. N-53.

II. RECOMMENDED AGREED ORDER

It is expressly agreed and understood that the provisions of this Recommended Agreed Order constitute a modification of Petitioner's modified Construction Permit No. SW133 and Operating Permit No. 45-2. To the extent that this Recommended Agreed Order is inconsistent with these two permits; the drawings and narrative submitted on November 14, 1980; or the State's February 16, 1982 letter, the provisions below shall supercede such inconsistent provisions, and shall govern construction and operations at the site from the date this Recommended Agreed Order is approved by EMB. (This date is hereafter called "the effective date of this Order.")

1. Condition No. 1 in the February 16, 1982 letter, to wit: Sandy, granular material under the unified soil classification SW and SP will not be used for daily cover at the site, remains unchanged.

2. Condition No. 4 in the February 16, 1982 letter is deleted and replaced by the following:

> Petitioner shall notify a staff member of the Indiana Division of Land Pollution Control (hereafter called "staff") by phone at least seven days in advance of the installation of any required leachate collection system on-site, to allow staff to inspect such installation.
>
> a. After such notification, Petitioner may install the system on the appointed day at the appointed hour, or as soon thereafter as weather permits, whether or not staff is present.
>
> b. If staff is not present for such installation, Petitioner shall document with photographs and narrative that the installation complies with Petitioner's amended construction permit.

c. Any required leachate collection system shall be installed in compliance with the amended construction permit.

3. Condition No. 5 in the February 16, 1982 letter regarding the discharge of water from the site into the Grand Calument River or other waters of the State of Indiana is deleted in its entirety.

4. Condition No. 6 in the February 16, 1982 letter is deleted and replaced by the following:

> It is not necessary that Petitioner install the seepage collection pond detailed on page seven of Petitioner's Engineering Plan. Petitioner agrees that no solid waste will be deposited in "standing water;" the phrase "standing water" shall not be construed to mean de minimus amounts of water or small rain-filled puddles.

5. Condition No. 7 in the February 16, 1982 letter is deleted and replaced by the following:

> The Clay Perimeter Seal along the southside of the site shall be constructed to an elevation of 589.7 MSL and shall be at least 10 feet wide. The parties expressly agree that the portion of Petitioner's landfill located at the southeastern portion of the site which is completed and at final grade as of December 14, 1982, will not be affected by this requirement.

6. Condition No. 8 in the February 16, 1982 letter is deleted and replaced by the following:

> The four on-site monitoring wells will be sampled on a quarterly basis. The sampling months are January, April, July, and October, with samples to be taken at the end of each month and analyzed.
>
> a. Results of these tests shall be submitted to staff by the end of the following month. The parameters to be tested are chloride,

chemical oxygen demand, total [illegible] iron, and total dissolved soli[illegible] [illegible]ness, total

b. Petitioner agrees to [illegible]vate or replace the one monito[illegible] [illegible]ate and reacti- its construction plans to be [illegible] well shown in eastern boundry of the site, if [illegible]ed along the possible to do so. [illegible] is physically

7. The modified construction [illegible]ns approved February 16, 1982, called for compaction of the [illegible]y perimeter wall around the site and testing the clay used [illegible] constructing this wall in accordance with the 90% Standard [illegible]octor Density Test. Petitioner has found it technicall[illegible] [illegible]d economically impractical to utilize this test. Respo[illegible]t has agreed to substitute for this test any test accepta[illegible] to staff which will accurately portray the permeabilit[illegible] the clay perimeter wall. Accordingly, Conditions two [illegible] three of the February 16, 1982, letter are deleted and re[illegible]ced with the following:

a. Within 45 days of the [illegible]fective date of this Order, or if weather cond[illegible]ns prevent taking the borings within this [illegible]e period, as soon thereafter as weather perm[illegible]. Petitioner will have four soil borings (wh[illegible] may be drilled at an angle) taken from the sit[illegible] west wall, at random locations along the wall [illegible]ith split spoon samples taken at five foot dep[illegible]nterval in each boring. Blowcounts will [illegible]ecorded for each split spoon sample taken. [illegible]e soil boring team will visually inspect the [illegible]lit spoon samples taken from each hole d[illegible]ed and keep a log of their observations to i[illegible]de any identifiable irregularities or voids [illegible]ountered during drilling. A total of five She[illegible] tube samples shall be taken from the boringe[illegible] The Shelby tube samples will be subjected to a [illegible]raulic conductivity test to ascertain the sa[illegible]s' permeability. Test results will be for[illegible]ed to staff within 15 days of their receipt [illegible] Petitioner. Staff shall be notified at leas[illegible]even days in advance of any such boring, and [illegible]ll be given an opportunity to attend and view [illegible]e drilling. Staff shall not interfere with [illegible]h operations.

b. If the test results s[illegible] the permeability of the clay wall to be [illegible] x 10^{-6} centimeters per second or less [illegible]. 4.5×10^{-6}, 4.0×10^{-6}, 3.0×10^{-6}, [illegible] x 10^{-6}, 1.0×10^{-6}, 1.0×10^{-7}, $1.0 \times$ [illegible] x 10^{-6}, then no remedial action for the [illegible], etc.), [illegible]t clay

perimeter wall will be required unless Staff identifies a significant infiltration of liquid as discussed in subparagraph 7c.

c. If the test results show that the permeability of the west perimeter wall is 5.1×10^{-6} centimeters per second or greater (i.e. 5.1×10^{-6}, 6.0×10^{-6}, 7.0×10^{-6}, 8.0×10^{-6}, 9.0×10^{-6}, 1.0×10^{-5}, 1.0×10^{-4}, etc.); or if Staff identifies a significant infiltration problem involving a concentrated flow of liquid into the site through the west wall or emanating from an area of deposited solid waste along that wall, then it is agreed that further negotiations between the parties will be required to determine what remedial action, if any, must be undertaken along the west wall. If the parties are unable to reach an agreement as to such remedial measures, if any, within 60 days of (i) the submission of the test results to the State, or (ii) the date a significant infiltration of liquid, Staff notifies Petitioner in writing of a finding of the issue of what remedial action may be required shall be submitted to the Hearing Officer for hearing and decision.

d. Until the soil boring tests are completed with satisfactory results in accordance with subparagraphs "a" and "b" above; or until an agreement is approved, or order entered pursuant to subparagraph "c" above, Petitioner agrees not to construct any further portions of the clay perimeter wall around the site.

i. If said test results are satisfactory in accordance with subparagraphs 7b, and no significant infiltration of liquid is identified in accordance with subparagraph 7c, then construction of the remaining portions of the clay perimeter wall shall proceed in the same manner as the construction of the west wall so as to ensure a permeability factor at least equivalent to the test results for the west wall and to ensure that infiltration of liquid into the site through these newly constructed walls does not occur. In this event, Petitioner will submit narrative to staff describing the method used to construct the west wall and will document the construction of the remaining portions of the clay perimeter wall with pictures and narrative to ensure consistent construction practices.

ii. If said test results are unsatisfactory, or a significant infiltration of liquid is identified in accordance with subparagraph 7c, the parties will attempt to negotiate an acceptable alternative for the construction of the remaining portions of the clay perimeter wall, or failing an

eement, submit the matter to the Hearing ficer for hearing and decision.

8. Condition nine of the February 16, 1982, letter is deleted and replaced by the following:

a. Petitioner's landfill will not be excluded from consideration as, and will be considered, one of the several sanitary landfills in Indiana which are, satisfactory repositories for special or "hazardous waste" as defined in 320 I.A.C. 5-2-1(19) (1982 Cum. Supp.) (hereafter called "special waste"). The parties specifically agree that no "hazardous waste" as defined and identified in 320 I.A.C. 4-3 (1982 Cum. Supp.) (hereafter called "RCRA hazardous waste") shall be deposited at Petitioner's landfill after the effective date of this Order.

b. Petitioner shall be permitted to continue receiving the following "special wastes" from the effective date of this Order until further action of the Board or Staff:

1. U.S. Reduction Dust;
2. Asbestos fill from Borg-Warner and Amoco Oil (which waste streams were subject to Special Permission letters dated 5/17/77 and 5/14/80, respectively);
3. Corn Starch and carbon filters from American Maize Products Company (which waste streams were subject to a Special Permission letter dated 2/20/76);
4. The following steel mill sludges from J & L Steel Corporation: the Central Treatment Plant Sludge, the Terminal Treatment Plant Sludge, and the Sludge from the 6 Stand Oil Recovery Unit.

c. After the effective date of this Order, staff will send a letter to the generators of the special wastes listed in subparagraph b above, requesting that the generators submit further information regarding the nature of the waste streams identified in subparagraph 8b above, to staff within 60 days of receipt of such letter; it is expressly agreed that this 60 day period will be extended by staff for good cause shown. Staff will analyze such updated information, make a final determination whether these listed special wastes may continue to be disposed of at the site, and shall promptly notify the generator of the waste and Petitioner of its decision. Any such decision shall constitute a "final action" for which Petitioner may file a Petition For Hearing before the Board pursuant to IND. CODE §§ 4-22-1 (1982) and 13-7-11-3 (1982). Any

special permission letters issued for these listed wastes shall last one year. Renewal of such letters will be granted if the materials do not change significantly in quality or quantity, and if Petitioner's operation of the site is in compliance with this Agreed Order, and Petitioner's modified construction permit and operating permit.

d. It is the parties' intention that other "special wastes" of similar quality, quantity and composition as; and other "special wastes" presenting similar environmental hazards as, the above-listed special wastes will be considered for disposal at the site. The decision whether to allow "special wastes" in addition to those listed above to be deposited at Petitioner's site, must be made by staff on a case-by-case basis after considering the physical and chemical composition of the proposed waste as well as current operations at the site. Although it is impossible to make any guarantees in advance, staff agrees in principle that, given satisfactory operations and construction at the site in compliance with this Order; Operating Permit 45-2; and the modified construction plans approved Febuary 16, 1982, waste streams with similar chemical and physical composition, and waste streams presenting similar environmental hazards as the special wastes listed in subparagraph "b" above, will be considered suitable for disposal at the site.

e. The parties agree that materials such as debris, wood, construction refuse, steel, etc.; "coal ash" including fly ash and bottom ash (i.e. the resultant "ash" from coal burning); may be disposed of at the site without any special permission letters.

f. Petitioner agrees to submit a quarterly report to staff setting forth the types and amounts of "special wastes" disposed of at the site. These reports will be due the same day for the same period as the monitoring well reports referred to in paragraph 6 above.

g. Finally, the parties agree to cooperate in good faith in exploring the possibility of depositing the Georgia Pacific paper sludges and municipal treatment plant sludges at the site.

9. The parties agree that Petitioner's Operating Permit and amended Construction Permit shall last for a period of two years from the effective date of this Agreed Order. The renewal of this Operating Permit and amended Construction Permit, or the decision of whether to grant or renew special permission

letters referred to in paragraph 8b, 8c and 8d above, shall be based upon Petitioner's compliance with this Agreed Order, Petitioner's modified construction permit and operating permit and IND. CODE § 13-7. For the purpose of renewals of existing special permission letters (subparagraph 8c), granting and renewal of additional special permission letters (subparagraph 8d), and the renewal of Petitioner's Operating Permit and amended Construction Permit (paragraph 9), the phrase "compliance with this Agreed Order, Petitioner's modified construction permit and operating permit" shall include but not be limited to (1) any de minimus or insignificant variations from the Agreed Order and/or Petitioner's modified construction permit and operating permit, and/or (2) any inspection report which contains demerits, but which still shows an "acceptable" rating, and/or (3) any unacceptable rating on 40 percent or less of the inspection reports conducted by the State in any 12 month period.

Petitioner, Gary Development, Inc.

By Lawrence H. Hagen
Lawrence Hagen, Vice President & General Manager

Date: 2/14/83

By John M. Kyle III
John M. Kyle III

INDIANA ENVIRONMENTAL MANAGEMENT BOARD

Technical Recommendation

By David D. Lamm
David D. Lamm, Director
Division of Land Pollution Control

Date: 2/16/83

Approved For Legality And Form

Linley E. Pearson
Attorney General of Indiana

By Matthew S. Schersachel
Mathew S. Scherschel
Deputy Attorney General

Date: 2/16/83

By _____
E. Victor Indiano

Barnes & Thornburg
Attorneys for Petitioner

Date: February 9, 1983

Recommendation For Adoption

By _____
Hearing Officer

Date: 2-15-83

Indiana Environmental Management Board

By _____
Ralph Pickard, Technical Secretary

Date: February 28 1983

Kearney

MANAGEMENT CONSULTANTS

A. T. KEARNEY, INC.
222 SOUTH RIVERSIDE PLAZA
CHICAGO, ILLINOIS 60606
312/648-0111

RECEIVED
JAN 09 1985
WASTE MANAGEMENT BRANCH

Mr. Chuck Lewis
Regional Project Officer
U.S. E.P.A. Region V
230 S. Dearborn Street
Chicago, Illinois 60604

January 7, 1985

Reference: Contract No. 68-01-6515; Work Assignment R05-005; Project 02; Task 06; Indiana Ground Water Reviews; Revised Checklists.

Dear Mr. Lewis:

In accordance with a conversation last week between myself and Martin Hamper, I am forwarding two copies of revisions made to the delivered checklists to correct inconsistencies between the checklist and the list of deficiencies provided. Although we are providing this to you after the completion of this project, we understand from Mr. Hamper that this information may still be useful to the Region and to Indiana.

If you have any questions, do not hesitate to call.

JAN 28 10 15 PM '85
DIV. OF LAND POLLUTION CONTROL
STATE BOARD OF HEALTH

Sincerely,

Jerald Gers

Jerald Gers, P.E.
Manager

Attachment

cc: A. Pearce - EPA (w/o Attachment)
G. Phillips - EPA (w/o Attachment)
M. Hamper - EPA
J. Tremblay - HLA (w/o Attachment)
J. Grieve
D. Beasley
K. Holub (w/o Attachment)

RECEIVED
DEC 17 1984

Harding Lawson Associates

Transmittal/Memorandum

To: A. T. Kearney, Inc.
222 South Riverside Plaza
Chicago, Illinois 60606

Attention: Mr. Jerald Gers, Manager

From: J. W. Tremblay
Date: December 14, 1984
Subject: Indiana
Job No.: 6273,055.12

Remarks:

Dear Jerry:

Enclosed are the materials we discussed. The administrative discrepancies for the Indiana sites have been noted and briefly discussed.

If you have any further questions, please do not hesitate to call.

Regards,

JFT:ja
Enclosure

cc:

Gary Land Development - (IND077005916)

- Inconsistencies noted between check list and list of deficiencies

  None noted.

- Items in check list and not in list of deficiencies

  A review of the ERTEC check list (copy attached) shows that virtually every facet of RCRA-required groundwater monitoring is insufficient, inadequate, or completely lacking at this site. Because of the magnitude of the problem, HLA did not list every deficiency item noted on the check list on the list of major deficiencies. We feel that the situation is covered by the general statements made on the list of deficiencies (i.e., ". . . the existing geologic and hydrologic data is insufficient," and ". . . due to the method of construction, the monitoring wells are inadequate for RCRA groundwater monitoring," etc.). A copy of the list of discrepancies is attached for information.

III ERTEC CHECKLIST

A. Summary

The following portions of the ERTEC Checklist were completed during the site inspection at GLDC:

> "Appendix A-1 Facility Inspection Form for Compliance with Interim Status Standards Covering Ground-Water Monitoring."
>
> "Appendix B - Ground-Water Monitoring and Alternate System Technical Information Form."

Since GLDC is not monitoring ground water in accordance with RCRA regulations, many of the questions contained in the Checklist are not applicable. However, an attempt was made to complete both forms as accurately as possible.

B. Deficiencies

The following deficiencies were noted during completion of the form and during the on-site well inspection:

1. Few of the documents required by RCRA have been completed. These include: the ground-water monitoring program, the ground-water sampling and analysis plan, and an outline of the ground water assessment program.

2. Many of the ground-water quality parameters required by RCRA regulations have not been established at the GLDC facility.

3. The existing geologic and hydrologic data is insufficient.

4. Due to the method of construction, the monitoring wells are inadequate for RCRA ground-water monitoring. The monitoring wells were installed in a hole which was excavated by a backhoe and was then backfilled with sand around a screen. Bentonite or concrete seals were not installed; thus, the wells are subject to contamination from surface. One well (S) was completed utilizing a steel casing, which was observed to be completely rusted through at the surface. All four existing wells contain bottom sediment, but since information concerning the original well depths was not available, the efficacy of the well screens could not be determined. In the event GLDC is required to do RCRA monitoring, new wells will have to be installed and properly completed in order to meet existing regulatory standards.

5. Suitable water collection, sample preservation, and chain-of-custody and preparation procedures have not been developed or utilized.

6. Since existing ground elevations at the site were not available, conclusive information concerning the direction of ground-water flow and hydraulic gradient could not be determined at this time.

APPENDIX A-1

FACILITY INSPECTION FORM FOR COMPLIANCE WITH INTERIM STATUS STANDARDS COVERING GROUND-WATER MONITORING

Company Name: Gary Land Development ; EPA I.D. Number: [illegible]5916

Company Address: Box 2-56 ; Inspector's Name: John M. Wilson

Gary, Indiana

Company Contact/Official: Larry H[illegible] ; Branch/Organization: _____

Title: [illegible] ; Date of Inspection: 9/19/84

	Yes	No	Unknown	Waive
Type of facility: (check appropriately)				
a) surface impoundment				
b) landfill				
c) land treatment facility				
d) disposal waste pile*				
Ground-Water Monitoring Program				
1. Was the ground-water monitoring program reviewed prior to site visit? If "No",		X		
a) Was the ground-water program reviewed at the facility prior to site inspection?	X			
2. Has a ground-water monitoring program (capable of determining the facility's impact on the quality of groundwater in the uppermost aquifer underlying the facility) been implemented? 265.90(a)		X		

*Listed separate from landfill for convenience of identification.

	Yes	No	Unknown	Waived
Has at least one monitoring well been installed in the uppermost aquifer hydraulically upgradient from the limit of the waste management area? 265.91(a)(1)	X			
a) Are ground-water samples from the uppermost aquifer, representative of background ground-water quality and not affected by the facility (as ensured by proper well number, locations and depths?)			X	
4. Have at least three monitoring wells been installed hydraulically downgradient at the limit of the waste handling or management area? 265.91(a)(2)	X			
a) Do well number, locations and depths ensure prompt detection of any statistically significant amounts of HW or HW constituents that migrate from the waste management area to the uppermost aquifer?			X	
5. Have the locations of the waste management areas been verified to conform with information in the ground-water program?	X			
a) If the facility contains multiple waste management components, is each component adequately monitored?			N/A	
6. Do the numbers, locations, and depths of the ground-water monitoring wells agree with the data in the ground-water monitoring system program? If "No", explain discrepancies.			No Data Furnished	
7. Well completion details. 265.91(c)				
a) Are wells properly cased?		X		
b) Are wells screened (perforated) and packed where necessary to enable sampling at appropriate depths?	X			
c) Are annular spaces properly sealed to prevent contamination of ground-water?		X		

	Yes	No	Unknown
8. Has a ground-water sampling and analysis plan been developed? 265.92(a)			
a) Has it been followed?			
b) Is the plan kept at the facility?			
c) Does the plan include procedures and techniques for:			
1) Sample collection?			
2) Sample preservation?			
3) Sample shipment?			
4) Analytical procedures?			
5) Chain of custody control?			
9. Are the required parameters in ground-water samples being tested quarterly for the first year? 265.92(b) and 265.92 (c)(1)			
a) Are the ground-water samples analyzed for the following:			
1) Parameters characterizing the suitability of the ground-water as a drinking water supply? 265.92(b)(1)			
2) Parameters establishing ground-water quality? 265.92(b)(2)			
3) Parameters used as indicators of ground-water contamination? 265.92(b)(3)			
(i) For each indicator parameter are at least four replicate measurements obtained at each upgradient well for each sample obtained during the first year of monitoring? 265.92(c)(2)			
(ii) Are provisions made to calculate the initial background arithmetic mean and variance of the respective parameter concentrations or values obtained from the upgradient well(s) during the first year? 265.92(c)(2)			
b) For facilities which have completed first year ground-water sampling and analysis requirements:			
1) Have samples been obtained and analyzed for the ground-water quality parameters at least annually? 265.92(d)(1)			
2) Have samples been obtained and analyzed for the indicators of ground-water contamination at least semi-annually? 265.92(d)(2)			

	Yes	No	Unknown
c) Were ground-water surface elevations determined at each monitoring well each time a sample was taken? 265.92(e)			
d) Were the ground-water surface elevations evaluated annually to determine whether the monitoring wells are properly placed? 265.93(f)			
e) If it was determined that modification of the number, location or depth of monitoring wells was necessary, was the system brought into compliance with 265.91(a)? 265.93(f)			
10. Has an outline of a ground-water quality assessment program been prepared? 265.93(a)*			
a) Does it describe a program capable of determining:			
1) Whether hazardous waste or hazardous waste constituents have entered the ground water?			
2) The rate and extent of migration of hazardous waste or hazardous waste constituents in ground water?			
3) Concentrations of hazardous waste or hazardous waste constituents in ground water?			
b) After the first year of monitoring, have at least four replicate measurements of each indicator parameter been obtained for samples taken for each well? 265.93(b)			
1) Were the results compared with the initial background means from the upgradient well(s) determined during the first year?			
(i) Was each well considered individually?			
(ii) Was the Student's t-test used (at the 0.01 level of significance)?			
2) Was a significant increase (or pH decrease as well) found in the:			
(i) Upgradient wells			
(ii) Downgradient wells			
If "Yes", Compliance Checklist A-2 must also be completed.			

*See note Page 2-10

	Yes	No	Unknown
11. Have records been kept of analyses for parameters in 265.92(c) and [illegible]? 265.94(a)(1)	___	___	N/A
12. Have records been kept of ground-water surface elevations taken at the time of sampling for each well? 265.94(a)(1)	X	___	
13. Have records been kept of required elevations in 265.93(b)? 265.94(a)(1)	___	___	N/A
14. Have the following been submitted to the Regional Administrator 265.94(a)(2) :*			
a) Initial background concentrations of parameters listed in 265.92(b) within 15 days after completing each quarterly analysis required during the first year?	___	___	N/A
b) For each well, have any parameters whose concentrations or values have exceeded the maximum contaminant levels allowed in drinking water supplies been separately identified?	___	___	N/A
c) Annual reports including:			
1) Concentrations or values of parameters used as indicators of ground-water contamination for each well along with required evaluations under 265.93(b)?	___	___	N/A
2) Any significant differences from initial background values in up-gradient wells separately identified?	___	___	N/A
3) Results of the evaluation of ground-water surface elevations?	___	___	N/A

*EPA will be proposing (Spring 1982) to replace this reporting requirement with an exception reporting system where reports will be submitted only where maximum contaminant levels or significant changes in the contamination indicators or other parameters are observed. EPA has delayed compliance stage for 14 a) above until August 1, 1982 (Federal Register, February 23, 1982, p.7841-7842) to be coupled with exception reporting in the interim.

APPENDIX B

GROUND-WATER MONITORING AND ALTERNATE SYSTEM
TECHNICAL INFORMATION FORM

1.0 Background Data:

Company Name: Gary Development ; EPA I.D.#: IND 077[illegible]

Company Address: Box 6056
Gary, Indiana 46406

Inspector's Name: John Wilson ; Date: 9/19/84

1.1 Type of facility (check appropriately):

1.1.1 surface impoundment X
1.1.2 landfill ___
1.1.3 land treatment facility ___
1.1.4 disposal waste pile ___

1.2 Has a ground-water monitoring system been established? (Y/N) Y

1.2.1 Is a ground-water quality assessment program outlined or proposed? (Y/N) N

If Yes,

1.2.2 Was it reviewed prior to the site visit? (Y/N) N/A

1.3 Has a ground-water quality assessment program been implemented or proposed at the site? (Y/N) N

If yes, Appendix C, Ground-Water Quality Assessment Program Technical Information Form must be utilized also.

2.0 Regional/Facility Map(s)

2.1 Is a regional map of the area, with the facility delineated, included? (Y/N) N

If yes,

2.1.1 What is the origin and scale of the map? ___

2.1.2 Is the surficial geology adequately illustrated? (Y/N) N/A

2.1.3 Are there any significant topographic or surficial features evident? (Y/N) Y

If yes, describe old borrowpit-drained to start landfill - Calumet River on S perimeter

2.1.4 Are there any streams, rivers, lakes, or wetlands near the facility? (Y/N) Y

If yes, indicate approximate distances from the facility Calumet River -

2.1.5 Are there any discharging or recharging wells near the facility? (Y/N) Y

If yes, indicate approximate distances from the facility. Sanitary pump-out well to facility office

2.2 Is a regional hydrogeologic map of the area included? (This information may be shown on 2.1) (Y/N) N

If yes:

2.2.1 Are major areas of recharge/dishcarge shown? (Y/N) N

If yes, describe.

2.2.2 Is the regional ground-water flow direction indicated? (Y/N) N/A

2.2.3 Are the potentiometric contours logical? (Y/N) N/A
If not, explain.

2.3 Is a facility plot plan included? (Y/N) Y

2.3.1 Are facility components (landfill areas, impoundments, etc.) shown? (Y/N) Y

2.3.2 Are any seeps, springs, streams, ponds, or wetlands indicated? (Y/N) Y

2.3.3 Are the locations of any monitoring wells, soil borings, or test pits shown? (Y/N) Y

2.3.4 Is the facility a multi-component facility? (Y/N) N

If yes:

2.3.4.1 Are individual components adequately monitored? (Y/N) ____

2.3.4.2 Is a Waste Management Area delineated? (Y/N) Y

2.4 Is a site water table (potentiometric) contour map included? (Y/N) N

If yes,

2.4.1 Do the potentiometric contours appear logical based on topography and presented data? (Consult water level data) (Y/N) N/A

2.4.2 Are groundwater flowlines indicated? (Y/N) N/A

2.4.3 Are static water levels shown? (Y/N) N/A

2.2.4 May hydraulic gradients be estimated? (Y/N) Y

2.4.5 Is at least one monitoring well located hydraulically upgradient of the waste management area(s)? (Y/N) Y

2.4.6 Are at least three monitoring wells located hydraulically downgradient of the waste management area(s)? (Y/N) Y

2.4.7 By their location, do the upgradient wells appear capable of providing representative ambient groundwater quality data? (Y/N) Y

If no, explain. ____

3.0 Soil Boring/Test Pit Details

3.1 Were soil borings/test pits made under the supervision of a qualified professional? (Y/N) Y

If yes,

3.1.1 Indicate the individual(s) and affiliation(s): Salisbury Eng

3.1.2 Indicate the drilling/excavating contractor, if known Salisbury Engineering, Griffith Indiana

3.2 If soil borings/test pits were made, indicate the method(s) of drilling/excavating:

- Auger (hollow or solid stem) X
- Mud rotary ___
- Air rotary ___
- Reverse rotary ___
- Cable tool ___
- Jetting ___
- Other, including excavation (explain) ___

3.3 List the number of soil borings/test pits made at the site

3.3.1 Pre-existing 6

3.3.2 For RCRA compliance ___

3.4 Indicate borehole diameters and depths (if different diameters and depths use TABLE B-1).

3.4.1 Diameter: ___

3.4.2 Depth: 40'

3.5 Were lithologic samples collected during drilling? (Y/N) Y

If yes,

3.5.1 How were samples obtained? (Check method(s))

- Split spoon ___
- Shelby tube, or similar X
- Rock coring ___
- Ditch sampling ___
- Other (explain) ___

INFORMATION TABLE B-1

BORING NO.	DEPTH	DIAMETER

3.5.2 At what interval were samples collected? _____

3.5.3 Were the deposits or rock units penetrated described? (boring logs, etc.) (Y/N) ____

3.6 If test pits were excavated at the site, describe procedures. _____

4.0 Well Completion Detail

4.1 Were the wells installed under the supervision of a qualified professional? (Y/N) N

If yes:

4.1.1 Indicate the individual and affiliation, if known Put in by Gary Land Development

4.1.2 Indicate the well construction contractor, if known GLD

4.2 List the number of wells at the site

4.2.1 Pre-existing 4 (for Ind. State Compliance)

4.2.2 For RCRA Compliance ____

4.3 Well construction information (fill out INFORMATION TABLE B-2)

4.3.1 If PVC well screen or casing is used, are joints (couplings): 2 PVC 2 steel

- Glued on X
- Screwed on ____

4.3.2 Are well screens sand/gravel packed? (Y/N) Y

4.3.3 Are annular spaces sealed? (Y/N) N

If yes, describe:

- bentonite slurry ____
- Cement grout ____
- Other (explain) _____

_____

- Thicknesses of seals _____

4.3.4 If "open hole" wells, are the cased portions sealed in place? (Y/N) N/A

If yes, describe how: _____

_____

_____

4.3.5 Are there cement surface seals? (Y/N) N

If yes,

- How thick? _____

4.3.6 Are the wells capped? (Y/N) Y

If yes,

- Do they lock? (Y/N) N

4.3.7 Are protective standpipes cemented in place? (Y/N) N

4.3.8 Were wells developed? (Y/N) N

If yes, check appropriate method(s):

- Air lift pumping ____
- Pumping and surging ____
- Jetting ____
- Bailing ____
- Other (explain) _____

_____

5.0 Aquifer Characterization

5.1 Has the extent of the uppermost saturated zone (aquifer) in the facility area been defined? (Y/N) N

If yes,

5.1.1 Are soil boring/test pit logs included? (Y/N) N

5.1.2 Are geologic cross-sections included? (Y/N) N

5.2 Is there evidence of confining (low permeability) layers beneath the site? (Y/N) Y

80' of clay - permeability 10^{-8} to 10^{-9}

If yes,

5.2.1 Is the areal extent and continuity indicated? (Y/N) Y

5.2.2 Is there any potential for saturated conditions (perched water) to occur above the uppermost aquifer? (Y/N) Y

If yes, give details: _____

a) Should or is this perched zone being monitored? (Y/N) Y

Explain Sand acts as Groundwater Table Aquifer

5.2.3 What is the lithology and texture of the uppermost saturated zone (aquifer)? Fine sand - white-gold - fairly pure to 35', then clay lenses, then solid clay

5.2.4 What is the saturated thickness, if indicated? 37'-38'

5.3 Were static water levels measured? (Y/N) N

If yes,

5.3.1 How were the water levels measured (check method(s)).

- Electric water sounder ____
- Wetted tape ____
- Air line ____
- Other (explain) ____

5.3.2 Do fluctuations in static water levels occur? (Y/N) N/A

If yes,

5.3.2.1 Are they accounted for (e.g. seasonal, tidal, etc.)? (Y/N) N/A

If yes, describe: _____

5.3.2.2 Do the water level fluctuations alter the general ground-water gradients and flow directions? (Y/N) N/A

If yes,

5.3.2.3 Will the effectiveness of the wells to detect contaminants be reduced? (Y/N) N/A

Explain _____

5.3.2.4 Based on water level data, do any head differentials occur that may indicate a vertical flow component in the saturated zone? (Y/N) ?

If yes, explain _____

5.4 Have aquifer hydraulic properties been determined? (Y/N) Y (?)

If yes,

5.4.1 Indicate method(s):

- Pumping tests ____
- Falling/constant head tests ____
- Laboratory tests (explain) ____

Estimated

5.4.2 If determined, what are the values for:

- Transmissivity 15,000 gpd/ft
- Storage coefficient ____
- Leakage ____
- Permeability 450 gpd/ft²
- Porosity ____
- Specific capacity ____

5.4.3 In cases where several tests were undertaken, were discrepancies in the results evident? (Y/N) N/A

If yes, explain _____

5.4.4 Were horizontal ground-water flow velocities determined? (Y/N) N

If yes, indicate rate of movement _____

6.0 Well Performance

6.1 Are the monitoring wells screened in the uppermost aquifer? (Y/N) Y

6.1.1 Is the full saturated thickness screened? (Y/N) N

6.1.2 For single completions, are the intake areas in the: (check appropriate levels)

- Upper portion of the aquifer ___
- Middle of the aquifer ___
- Lower portion of the aquifer X

6.1.3 For well clusters, are the intake areas open to different portions of the aquifer? (Y/N) N/A

6.1.4 Do the intake levels of the monitoring wells appear to be justified due to possible contaminant density and groundwater flow velocity? (Y/N) Y

7.0 Ground-Water Quality Sampling

7.1 Is a sampling (groundwater quality) program and schedule included? (Y/N) N

7.2 Are sample collection field procedures clearly outlined? (Y/N) N

7.2.1 How are samples obtained: (check method(s))

- Air lift pump ___
- Submersible pump ___
- Positive displacement pump ___
- Centrifugal pump ___
- Peristaltic or other suction-lift pump ___
- Bailer X
- Other (describe) ___

7.2.2 Are all wells sampled with the same equipment and procedures? (Y/N) Y

If no, explain ___

7.2.3 Are adequate provisions included to clean equipment after sampling to prevent cross-contamination between wells? (Y/N) N

7.2.4 Are organic constituents to be sampled? (Y/N) N

If yes,

7.2.5 Are samples collected with equipment to minimize absorption and volatilization? (Y/N) N/A

If yes,

Describe equipment _____

_____

_____

8.0 Sample Preservation and Handling

8.1 Have appropriate sample preservation and preparation procedures been followed (filtration and preservation where appropriate)? (Y/N) N

8.2 Are samples refrigerated? (Y/N) N (Samples delivered w/in 1h

8.3 Are EPA recommended sample holding period requirements adhered to? (Y/N) Y

8.4 Are suitable container types used? (1 gal. plastic jugs) (Y/N) Y

8.5 Are provisions made to store and ship samples under cold conditions (ice packs, etc.)? (Y/N) N

8.6 Is a chain of custody control procedure clearly defined? (Y/N) N

8.7 Is a specific chain of custody form illustrated? (Y/N) N

If yes,

8.7.1 Will this form provide an accurate record of sample possession from the moment the sample is taken until the time it is analyzed? (Y/N) N/A

9.0 Sample Analysis and Record Keeping

9.1 Is sample analysis performed by a qualified laboratory? (Y/N) unk

Indicate lab Lake County Health Department

9.2 Are analytical methods described in the records? (Y/N) N

9.2.1 Are analytical methods acceptable to EPA? (Y/N) unk

9.3 Are the required drinking water suitability parametters tested for? (Y/N) N

9.4 Are the required groundwater quality parameters tested for? (Y/N) N

9.5 Are the required ground-water contamination indicator parameters tested for? (Y/N) N

9.6 Are any analytical parameters determined in the field? (Y/N) N

Identify:

- pH _____
- Temperature _____
- Specific conductance _____
- Other (describe) _____

_____

9.7 Is a plan included to record information about each sample collected during the groundwater monitoring program? (Y/N) N

9.7.1 Are field activity logs included? (Y/N) N

9.7.2 Are laboratory results included? (Y/N) Y

9.7.3 Are field procedures recorded? (Y/N) N

9.7.4 Are field parameter determinations included? (Y/N) N

9.7.5 Are the names and affiliation of the field personnel included? (Y/N) N

9.8 Are statistical analyses planned or shown for all water quality results where necessary? (Y/N) N

9.8.1 Is an analysis program set-up which adheres to EPA guidelines? (Y/N) N

9.8.2 Is Student's t-test utilized? (Y/N) N
If other evaluation procedure used, identify _____

_____

9.8.3 Are provisions made for submitting analysis reports to the Regional Administrator? Submit to Indiana EMB (Y/N) N

10.0 Site Verification

10.1 Plot Plan indicating the locations of various facility components, ground-water monitoring wells, and surface waters? (Y/N) Y

10.1.1 Is the plot plan used for the inspection the same as in the monitoring program plan documentation? (Y/N) Y

If not, explain _____

_____

10.1.2 Are all of the components of the facility identified during the inspection addressed in the monitoring program documentation? (Y/N) Y

If not, explain _____

10.1.3 Are there any streams, lakes or wetlands on or adjacent to the site? (Y/N) Y

If yes, indicate distances from waste management areas Colorado River & Border

10.1.4 Are there any signs of water quality degradation evident in the surface water bodies? (Y/N) N

If yes, explain _____

10.1.5 Is there any indication of distressed or dead vegetation on or adjacent to the site? (Y/N) N

If yes, explain _____

10.1.6 Are there any significant topographic or surficial features on or near the site (e.g., recharge or discharge areas)? (Y/N) N

If yes, explain _____

10.1.7 Are the monitor well locations and numbers in agreement with the monitoring program documentation? (Y/N) Y

If no, explain (No numbers on Wells)

10.1.7.1 Were locations and elevations of the monitor wells surveyed into some known datum? (Y/N) N

If not, explain _____

10.1.7.2 Were the wells sounded to determine total depth below the surface? (Y/N) ___

If not, explain ___

10.1.7.3 Were discrepancies in total depth greater than two feet apparent in any well? (Y/N) N/A

If yes, explain no records of depths available

10.1.8 Was ground water encountered in all monitoring wells? (Y/N) Y

If not, indicate which well(s) were dry ___

10.1.9 Were water level elevations measured during the site visit? (Y/N) Y

If yes, indicate well number and water level elevation ___

If not, explain See next two pages

WATER LEVEL MEASUREMENTS

Gay Lank SITE

9/19/89 DATE

WELL NUMBER		TAPE HELD	MINUS TAPE WET	SUB TOTAL	MINUS STICK UP	WATER LEVEL (LSD)	LAND ELEV.	WATER LEVEL ELEV
N	measured	17	0.60	16.4	3.15	13.25		576.6
	reported						589.85	
S	measured	6	1.46	4.54	1.5	3.04		593.96
	reported						597.0	
E	measured	19	1.40	17.6	1.5	16.1		576.4
	reported						592.5	
W	measured	6	1.11	4.59	3.41	1.18		556.71
	reported						558.19	
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							

Harding Lawson Associates

DATE

WELL DEPTH [illegible] EVENT
[illegible] SITE
9/19/84 DATE

* Estimates from topo plots of facility

WELL NUMBER		TAPE DROPPED	MINUS FACTOR	SUB TOTAL	MINUS STICK UP	TOTAL DEPTH (LSD)	LAND ELEV.	BOTTOM ELEV.
N	measured	58.06	35.97	22.09	3.15	18.94		570.91
	reported						589.85	
S	measured	51.68	35.97	15.71	1.5	14.21		572.79
	reported						587.0	
E	measured	55.92	35.97	19.95	1.5	18.45		574.05
	reported						592.5	
W	measured	51.18	35.97	15.21	3.41	11.8		576.39
	reported						588.19	
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							
	measured							
	reported							

Harding Lawson Associates

N & S - 6" steel
W & E - 6" PVC

All 4 wells contain sediment

MAR 1 2 1985

"Complainant's Exhibit No. 5"

5HS-12

Lawrence Hagen, Vice President
Gary Development Company, Incorporated
479 North Cline Avenue
Gary, Indiana 46406

RE: Ground-water Protection Requirements
Gary Development Co., Incorporated
IND 077006916

Dear Mr. Hagen:

On November 8, 1984, the President of the United States of America signed into law the Hazardous and Solid Waste Amendments of 1984 (HSWA). This new law amends the Resource Conservation and Recovery Act (RCRA), and contains provisions which have far reaching effects on how hazardous wastes are managed in this country.

The purpose of this letter is to inform you of one of the many provisions of the HSWA and how it may affect your facility. This is not a request for submission of your facility's Part B permit application.

A new Subsection (i) was added to Section 3005 of RCRA (HSWA Section 243 (c)) which concerns the applicability of 40 CFR Part 264 Subpart F ground-water protection requirements. This new provision states that any landfill, surface impoundment, land treatment unit or waste pile which receives hazardous waste after July 26, 1982, is now subject to these more stringent ground-water monitoring and response programs upon issuance of a permit. This is applicable to either operating permits or post-closure care permits. Prior to the enactment of the HSWA, the 40 CFR Part 264 Subpart F requirements applied to those facilities which receive hazardous wastes after January 26, 1983.

Please contact Mr. Martin Harper of my staff at (312) 886-6984, if you have any questions concerning this matter.

Sincerely yours,

Karl J. Klepitsch, Jr.
Chief, Solid Waste Branch

cc: Quinn Doyle, ISDH

bcc: File	TYPIST	5HS/Hart AUTHOR	STU #1 CHIEF	STU #2 CHIEF	STU #3 CHIEF	TPS CHIEF	CHIEF	DIRECTOR
INITIALS	VC	[illegible]	[illegible]			[illegible]	[illegible]	
DATE	3/4/85	3/4/85	3/5/85			3/8/85	3/8/85	

3/4/85

3/8/85

MAR 1 8 1985

"Complainant's Exhibit No. 6"

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Lawrence Hagen
Gary Development Co., Inc.
479 North Cline Avenue
Gary, Indiana 46406

RE: Gary Development Company, Incorporated
IND 077005916

Dear Mr. Hagen:

Previously, you should have received an acknowledgment of our receipt of the Part A permit application material for the above-referenced hazardous waste facility under the Resource Conservation and Recovery Act (RCRA) permit program. Accordingly, this letter constitutes the next step in the formal process leading toward issuance or denial of a RCRA permit. Under the authority of 40 CFR 270.10, this is a formal request for submittal of Part B of the permit application for the above-referenced facility.

Also, this letter is to inform you that on November 8, 1984, the Hazardous and Solid Waste Amendments of 1984 (HSWA) were signed into law. This new law amends RCRA, and contains many provisions which may effect your facility. One important provision mandates that interim status for land disposal facilities shall terminate on November 8, 1985, unless the Part B permit application and a certification of compliance with 40 CFR Part 265 Subpart F and K requirements is submitted by November 8, 1985. Enclosed are copies of the HSWA provisions and a HSWA guidance document for selected issues related to permit applications for land treatment, storage and disposal facilities.

Enclosed is a copy of 40 CFR 270.14, which lists the items required for submitting the Part B permit application for the facility (regulations promulgated prior to the enactment of HSWA). The Part B application must be submitted in quadruplicate and postmarked no later than September 15, 1985. The original and one copy of the application must be sent to the United States Environmental Protection Agency (U.S. EPA). The other two copies must be sent to the Indiana State Board of Health (ISBH). Please uniquely number each page of the application including all attachments (maps, specifications, etc.). A certification statement identical

to the one stated in 40 CFR 270.11(d) must accompany each application and all additional submittals. Send your application to the following addresses:

RCRA ACTIVITIES
Part B Permit Application
U.S. EPA, Region V
P.O. Box [illegible]
Chicago, Illinois [illegible]

Part B Permit Application
Division of Land Pollution Control
Indiana State Board of Health
1330 West Michigan Street
Indianapolis, Indiana 46206

Attention: Terry F. Gray

We are committed to conducting the RCRA permitting process as efficiently as possible. Consequently, I suggest you contact Mr. Martin Hamper of my staff, at (312) 886-6904, as you begin preparing your application. Mr. Hamper will be available to discuss specific needs of your application or to meet with you in Chicago. These efforts are intended to generate complete applications, without requiring any information beyond that which is necessary to make RCRA permit decisions.

Failure to furnish the complete Part B permit application by the above date, and to provide in full all required information, is grounds for termination of interim status under 40 CFR 270.10.

Information in the Part B permit application can be disclosed to the public, according to the Freedom of Information Act and U.S. EPA Freedom of Information regulations. If you wish, however, you may assert a claim of business confidentiality by printing the word "Confidential" on each page of the application which you believe contains confidential business information. All incoming materials containing confidential business information should be sent in a double envelope—one envelope inside the other. The inner envelope is to be addressed to the Docket Control Officer (DCO) with the following instructions: "to be opened only by the DCO."

U.S. EPA will review business confidentiality claims under regulations in 40 CFR Part 2, and may later request substantiation of such claims. Please review these rules carefully before making a claim. If you claim parts of your application as confidential, please provide us with a public information copy of the application. The public information copy must be identical to the full application with the exclusion of the confidential information.

We have also enclosed a copy of 40 CFR Part 264, (regulations promulgated prior to the enactment of HSWA) which includes technical standards for the operation of treatment, storage, and disposal facilities. These standards will become applicable to your facility upon issuance of a RCRA permit by U.S. EPA. A copy of our "Guidance For Permit Application Preparation" and "Part B Completeness Checklist" are also enclosed; they will help you in preparing a comprehensive and complete permit application.

Also enclosed is a "Certification Regarding Potential Releases from Solid Waste Management Units" which will help you address the requirements of HSWA Section 206 concerning continuing releases at permitted facilities.

We will coordinate review of the application with the (ISDH), and will strive for the simultaneous issuance of Federal and State hazardous waste facility permits. It is possible that during the processing of the application, the State hazardous waste program may become authorized to issue RCRA permits for your type of facility. In that case, direct Federal processing will cease, and ISDH in lieu of U.S. EPA will make the final determination on your permit application.

Within 90 days after this formal request for Part B of the permit application for the facility, representatives from U.S. EPA and/or ISDH are planning to conduct a pre-permit facility inspection. The inspection will be coordinated with you ahead of time, so that we can work together for a clear understanding of the permit application and compliance requirements. Your early familiarity with requirements of the Part B permit application should result in time savings for your facility and preparation of a higher quality permit application.

We look forward to working with you.

Sincerely yours,

Karl J. Klepitsch, Jr., Chief
Solid Waste Branch

Enclosures: 40 CFR 270 (applicable parts)
40 CFR 264 (applicable parts)
Guidance For Permit Application Preparation
Part B Completeness Checklist
Guidance on Early Enactment Provisions of HSWA
Certification Regarding Potential Releases
From Solid Waste Management Units

cc: David Lamb, ISDH

bcc: Part A File
Ken Burch, GMCU

SHS/Hamper:vc 3/12/85

	TYPIST	AUTHOR	STU #1 CHIEF	STU #2 CHIEF	STU #3 CHIEF	TPS CHIEF	WMB CHIEF	WMD DIRECTOR
INITIALS	VC	RAV	KC			RJ	KJK	
DATE	3/13/85	3/15/85	3/13/85			3/15/85	3/15/85	3/15/85

STATE OF INDIANA

STATE BOARD OF HEALTH

AN EQUAL OPPORTUNITY EMPLOYER

INDIANAPOLIS

Address Reply to:
Indiana State Board of Health
1330 West Michigan Street
P. O. Box 1964
Indianapolis, IN 46206-1964

March 29, 1985

"Complainant's Exhibit No. 7"

President
Gary Development Company, Inc.
479 North Cline Avenue
Gary, IN 46406

Dear Sir:

Re: U.S. EPA I.D. #IND 077005916

Our records indicate that the above-referenced facility has not submitted proof of financial assurance for closure/post-closure or liability coverage as required by the Indiana RCRA financial assurance rules, 320 IAC 4-7-1 through and including 320 IAC 4-7-36, a copy of which has been enclosed. Failure to respond to this notice within 30 days will result in initiation of an administrative enforcement action. If you have any questions regarding this matter, please contact me at AC 317/243-5046.

Very truly yours,

Jeffrey W. Stevens

Jeffrey W. Stevens
Division of Land Pollution Control

JWS/sk
Enclosure
cc: Ms. Sally Swanson, U.S. EPA, Region V

SK 16478

① Boyle - FYI
② Compliance F

William
Tim

Muno
VEM 5/10

STATE OF INDIANA

STATE BOARD OF HEALTH

AN EQUAL OPPORTUNITY EMPLOYER

INDIANAPOLIS

Address Reply to:
Indiana State Board of Health
1330 West Michigan Street
P.O. Box 1964
Indianapolis, IN 46206-1964

May 1, 1985

Mr. Warren D. Krebs
Parr, Richey, Obrenskey, and Morton
225 West Main Street
P.O. Box 666
Lebanon, IN 46502

"Complainant's Exhibit No. 8"

Dear Mr. Krebs:

IND 077 005 916

Re: Gary Development Company, Inc.
GARY, IN

This will acknowledge the receipt of your hand-delivered letter of April 16, 1985.

We have reviewed the information in our files concerning your client's hazardous waste activities. Copies of the relevant documents are enclosed. Based on the information the Division of Land Pollution Control has, it would seem that there has been poor communication between your client and you. It also seems that you have confused the roles and responsibilities of the U.S. Environmental Protection Agency (EPA) and the Indiana Environmental Management Board in implementing the Hazardous Waste Management Program established by the Resource Conservation and Recovery Act (42 USC 3251, et seq.).

Gary Development Company's previous attorney has admitted that hazardous waste was disposed of by your client after the effective date (December 19, 1980) of the Federal hazardous waste regulation (see January 24, 1984, letter from Mr. John M. Kyle, III). The U.S. EPA has informed your client (by letter dated February 8, 1984, to Mr. John M. Kyle, III) that your client was a regulated facility. Therefore, it should come as no surprise to your client that he be required to submit information to determine his compliance with the State's hazardous waste management rules.

You expressed your lack of knowledge concerning how a landfill can be "officially" classified as a hazardous waste disposal facility. We would direct your attention to 40 CFR 270.10, 270.13, and 270.7(b), as well as Section 3010 of the Resource Conservation and Recovery Act. It is our further understanding that your client has, in fact, submitted an EPA permit application (commonly called Part A) in which he certified that he did, in fact, operate a hazardous waste management facility.

We would further point out that, in Indiana at the present time, it is the responsibility of the U.S. EPA to determine whether or not your client is required to have a permit for a hazardous waste management facility. The Indiana Environmental Management Board has only been delegated the authority to act in lieu of the U.S. EPA to enforce the interim status standards which are set out in 40 CFR 265. Your question concerning the ". . . right to appeal any initial administrative determination . . ." must be addressed, in this instance, to the Regional Administrator.

In closing, let me make clear that all evidence to date supports the claim that the Gary Land Development Company, Inc., is regulated pursuant to both Federal and State hazardous waste management rules. Failure by your client to comply with all applicable requirements can only result in Federal and/or State enforcement actions which would subject your client to significant civil penalties.

Very truly yours,

Guinn Doyle

Guinn Doyle, Chief
Hazardous Waste Management Branch
Division of Land Pollution Control

GPD/tr
Enclosures
cc: Mr. William Miner, U.S. EPA, Region V
Mr. Lawrence Hagen

"Complainant's Exhibit No. 9"

[redacted]

Indiana State Board of Health
Division of Land Pollution Control
Hazardous Waste Landfill Inspection Report

FACILITY Gary Development Co. Inc. DATE 6-17-85
ADDRESS 4279 N. Cline Ave TIME 12:30p
CITY/COUNTY Gary
PERSON(S) INTERVIEWED Mr Larry Hagen

I. ANALYSES AND APPROVALS	YES	NO	COMMENT
1. General waste analyses on file for wastes received		✓	
2. General waste analysis plan on file		✓	
3. State approvals on file for wastes received		✓	
II. PREPAREDNESS AND PREVENTION			
1. Internal communications functional		✓	
2. Telephone or two-way radios functional		✓	
3. Emergency equipment (extinguishers, spill control, safety equipment) functional		✓	
4. Contingency plan on file		✓	
III. MANIFESTING			
1. Only manifested shipments of hazardous waste accepted		✓	
2. Signed and dated as required		✓	
3. Manifests retained in file		✓	
4. Manifest discrepancies addressed		N/A	
manifests at office - search needed			
IV. OPERATING RECORD			
1. Description and quantity of waste received noted		✓	
2. Date waste received and date of disposal noted		✓	
3. Location and quantity of wastes in each cell noted on map and cross-referenced to manifest document		✓	
NO			
V. INSPECTIONS			
1. Inspections of emergency equipment conducted		✓	
2. Inspection of security devices conducted		✓	
3. Inspection log contains date, time, and inspector		✓	
VI. SECURITY			
1. Twenty-four (24) hour surveillance or artificial barrier	X		
2. Controlled entry onto site	X		
3. "Danger Signs" posted as required	[redacted]	X	

VII. OPERATING REQUIREMENTS

	YES	NO	COMMENT
1. Run-on diverted away from active portion	✓		
2. Run-off from active portion collected		✓	
3. Wind dispersal of wastes controlled	✓		N/I
4. Daily cover applied (12 inches minimum)			N/I
5. Ignitable/reactive wastes not accepted			N/I
6. Incompatible wastes not placed in same cell			N/I
7. No "free liquid" wastes accepted for disposal			N/I
8. Empty containers reduced in volume prior to burial			N/I
9. Containers managed to prevent damage to liner			N/I
10. Leachate levels checked			
11. Date leachate last pumped no leachate collection system			
12. Hazardous waste retained in hazardous waste area			N/I

COMMENTS

other than a pond

INSPECTED BY: Ted Warner DATE: 6/17/85

Tom Russell

0059M
gds

Martin

STATE OF INDIANA

INDIANAPOLIS

STATE BOARD OF HEALTH

AN EQUAL OPPORTUNITY EMPLOYER

Address Reply to:
Indiana State Board of Health
1330 West Michigan Street
P.O. Box 1964
Indianapolis, IN 46206-1964

RECEIVED

JUL 23 1985

SOLID WASTE BRANCH
U.S. EPA, REGION V

July 16, 1985

Mr. Martin Hamper
U.S. EPA, Region V
230 South Dearborn Street
Chicago, IL 60604

"Complainant's Exhibit No. 10"

Dear Mr. Hamper:

Re: Part B Call-In for
Gary Development Company, Inc.
Gary, Indiana
IND 077005916

On May 2, 1985, Ms. Sheryl Atkins of my staff contacted Mr. Larry Hagen, Sr., of Gary Development Company, Inc., in an effort to schedule a permit writer's site visit. Mr. Hagen was uncooperative regarding his facility's status as a TSD and told Ms. Atkins that he would get back with her after he had time to speak with his attorney. Ms. Atkins received no reply.

At Ms. Atkins' request, Gary Development Company, Inc., was inspected on June 17, 1985, by Mr. Ted Warner of the Compliance Monitoring Section. During the inspection, Mr. Warner and Mr. Hagen were in agreement that the facility had accepted hazardous waste, and Mr. Hagen indicated that he intended to go through closure.

Ms. Atkins contacted Mr. Hagen once again on June 21, 1985, to request a letter from the Company indicating their intentions to close. Mr. Hagen was reluctant to discuss the matter with Ms. Atkins, and once again deferred the requested documentation to his attorney. At the date of this writing, there has been no response to Ms. Atkins' second request either.

It is Ms. Atkins' understanding that Mr. Warner will refer the case to the Division's Enforcement Section and that closure will be requested at a minimum as part of the enforcement action against this Company.

If you have any questions regarding this matter, please contact Ms. Atkins at AC 317/243-5091.

Very truly yours,

Terry F. Gray

Terry F. Gray, Chief
Plan Review and Permit Section
Hazardous Waste Management Branch
Division of Land Pollution Control

SKA/tr
cc: Mr. Hak Cho, U.S. EPA, Region V
Mr. Kenneth Burch, U.S. EPA, Region V

Enf. Sect, 3

STATE BOARD OF HEALTH

INDIANAPOLIS

OFFICE MEMORANDUM

DATE: July 29, 1985

TO: RCRA File

THRU: Dave Berrey

FROM: Ted Warner
Compliance Monitoring Section

"Complainant's Exhibit No. 11"

SUBJECT: Scheduled Inspection of
Gary Development Company, Inc.
Gary, Indiana
IND 077005916

On June 17, 1985, Mr. Thomas Russell, Chief, Enforcement Section, and I conducted an inspection of the Gary Development Company, Inc., Landfill located at 479 North Cline Avenue, Gary, Indiana. The facility was represented by Mr. Lawrence Hagen.

The pre-inspection file audit revealed that this facility submitted an EPA Part A. The facility notified for landfilling the following hazardous wastes: F006, K087, F005, and F003. The facility received 33 manifested shipments of hazardous waste labeled F005 from American Chemical Services in 1981. On March 18, 1985, a Part B call-in letter was sent to Mr. Hagen of Gary Development. This facility has had a continuous stream of correspondence concerning the status at the facility. The Division of Land Pollution Control, Hazardous Waste Management Branch Chief, Mr. Guinn Doyle, stated in a letter on May 1, 1985, to Gary Development, that the "Gary Development Landfill is regulated pursuant to both Federal and State hazardous waste management rules." The U.S. EPA, Region V, Waste Management Branch Chief, the late Mr. Karl J. Klepitsch, Jr., stated in his February 8, 1984, letter that, "In summary, (1) Gary Development Landfill is in violation of RCRA Section 3005, plus 40 CFR 6270.2(c), 270.10(a), and 124.3(e) for disposal of hazardous waste without a permit; (2) the Landfill is subject to regulation under 320 IAC, Article 4; and (3) the Landfill must undergo closure pursuant to these regulations to avoid enforcement action by this office." It is also important to note that no State application or U.S. EPA Form 8700-12 was filed. Therefore, it is the opinion of the Technical Programs Section Chief, Mr. William Miner, in a letter to Mr. Hagen on June 18, 1982, that Gary Development "does not have interim status as defined in 40 CFR 122.23."

The final area of importance discovered during the file audit is the existence of an Environmental Management Board complaint, Cause No. N-146. This document reveals the solid waste history of the Gary Development Landfill and the problems and violations that are yet to be resolved.

During Mr. Russell's and my interview of Mr. Hagen, he stated that his facility had filed a Part A application, but had not filed a "postcard" notification. Mr. Hagen had been informed by an EPA attorney that Gary Development did not have interim status. Mr. Hagen did admit that his facility received 28 to 33 loads of manifested paint sludge from American Chemical Services in, to the best of his knowledge, 1980 or 1981. He did not know for sure where those manifests were located within his office. Mr. Hagen also stated that Gary Development received broken battery cases and neutralized calcium sulfate sludge from USS Lead Company of East Chicago. I have a working knowledge of that waste and the neutralized calcium sulfate is a characteristic hazardous waste, D008.

We asked Mr. Hagen to demonstrate Gary Development's compliance with all of the different aspects of RCRA requirements, and the only area that the facility was in compliance with was artificial barrier and control of entry.

Mr. Hagen provided us with a tour of the landfill. He pointed out the area of the landfill that was being co-disposed during the time period of receiving the manifested hazardous waste from American Chemical Services. We did observe a leachate collection pond that appeared very discolored. We asked Mr. Hagen if that liquid had been analyzed and he stated that it had not been sampled. Mr. Hagen went on to show us the four monitoring wells on the site. He stated that the wells are tested and analyzed for only 330 IAC 4 parameters. The wells are located on the north, south, east, and west sides of the facility. Following our tour, Mr. Russell recapped our visit by stating that, at a minimum, a complaint would have to be filed and the complaint would ask for formal closure of the facility.

In conclusion, this facility appears to have operated without interim status and outside any reasonable compliance with RCRA protocol. The facility has accepted hazardous waste in the past, therefore, it must go through closure. I will prepare an enforcement referral in the form of a complaint asking for the formal closure and post-closure of the Gary Development Company, Inc., Landfill.

TFW/tr
cc: Enforcement Section

STATE OF INDIANA

STATE BOARD OF HEALTH

AN EQUAL OPPORTUNITY EMPLOYER

INDIANAPOLIS

Address Reply to:
Indiana State Board of Health
1330 West Michigan Street
P. O. Box 1964
Indianapolis, IN 46206-1964

October 22, 1985

"Complainant's Exhibit No. 12"

Mr. William Miner, Chief
Hazardous Waste Enforcement Branch
U.S. EPA, Region V
230 South Dearborn Street
Chicago, IL 60604

Dear Mr. Miner:

Re: Enforcement Referral
Gary Development, Inc.
Gary, Indiana

Enclosed is a hazardous waste enforcement referral from the Enforcement Section of our Hazardous Waste Management Branch. Mr. Thomas Russell of our staff has discussed the Gary Development, Inc., situation with Mr. Joe Boyle of your office and it was mutually agreed that the Resource Conservation and Recovery Act violations at this facility should be handled by U.S. EPA.

It is our understanding that U.S. EPA is preparing to send this facility a compliance order for failure to have submitted their Part B permit application as requested. Due to this, and the fact that our Geology Section is currently understaffed and unable to complete groundwater monitoring plan reviews in a timely manner, it was decided that U.S. EPA should be the lead agency in resolving the violations at this facility.

If you or your staff have any questions regarding this matter, please contact Mr. Russell of our Enforcement Section at AC 317/243-5012.

Very truly yours,

Quinn Boyle for

David D. Lamm, Director
Division of Land Pollution Control

TLR/tr
Enclosures
cc: Ms. Sally K. Swanson, U.S. EPA, Region V
Ms. Karyl Schmidt
Mr. Ted Warner
Ms. Pat Vogtman, U.S. EPA, Region V

ENFORCEMENT SENSITIVE

HAZARDOUS WASTE
ENFORCEMENT REFERRAL

TO: William Miner, Chief
Hazardous Waste Enforcement Branch
U.S. EPA, Region V

FROM: David D. Lamm, Director
Division of Land Pollution Control
Indiana State Board of Health

TRACKING INFORMATION (or submit CMEL)
Originators Name: Ted F. Warner
Initial Evaluation: 6/17/85
Next (Follow-up) Evaluation Date: _____
Evaluation Type (3 letter code): SCE
Evaluation Comment (60 character limit): Facility desires RCRA closure

---

FACILITY OR HANDLER DESCRIPTION:

Gary Development Company, Inc.
479 North Cline Avenue
P.O. Box 6056
Gary, Indiana 46406
Contact Person: Lawrence Hagen, Vice-President
EPA I.D. No. IND 077005916

The facility submitted a Part A permit application on November 18, 1980, and claims to have submitted notification to U.S. EPA, although U.S. EPA has no record of receiving the notification. U.S. EPA accordingly has stated the facility does not have interim status. The Part A listed 100 acre feet of landfill capacity and disposal availability for K054, D001, and D002 wastes.

The facility is a conventional hazardous waste landfill, OPP. No. 45-2, which has had some compliance problems with our Solid Waste Management Branch (see Hearing Officer's Findings and Recommended Order in Cause No. N-146, enclosed). As a conventional landfill, the facility has a limited groundwater monitoring program pursuant to 330 IAC 4, but no RCRA Subpart F program has been initiated at the facility.

SUMMARY OF CASE OR REFERRAL:

An inspection was conducted at the facility on June 17, 1985, by Messrs. Ted Warner and Tom Russell of the Division of Land Pollution Control. The facility has not attempted to meet any applicable RCRA or 320 IAC 4 requirements. The receipt and deposition of certain hazardous wastes at the facility was confirmed. It is Mr. Hagen's

desire to go through closure and get out of the RCRA program. During the inspection interview, Mr. Hagen repeatedly replied in the negative to queries regarding their compliance with RCRA requirements. None of the required paperwork, i.e., waste analysis plan, operating record, contingency plan, closure plan, was available for inspection, nor had it been developed.

Mr. Hagen stated they had received 28 to 33 loads of paint sludge from American Chemical as F007 in 1981 or 1982 and had also received broken battery casings and neutralized acids from U.S.S. Lead. He further stated that any hazardous wastes received were commingled with conventional refuse for disposal. The facility is not currently accepting hazardous wastes for disposal.

When asked about compliance with Subpart F at the facility, Mr. Hagen stated they had only a conventional groundwater monitoring program consisting of four wells located to the north, south, east, and west of the landfill proper and that these were sampled only for solid waste parameters.

In summary, EPA has not granted interim status to this facility, yet they have accepted hazardous wastes for disposal, they have not attempted to comply with federal or State hazardous waste operating requirements, and desire to get out of the hazardous waste management program. A Compliance Order is recommended requiring the development of a closure plan and, following its approval, that the facility implement the closure plan as approved.

The facility's Part B permit application has been called in by U.S. EPA, but, to our knowledge, no submittal was made as required.

SPECIFIC VIOLATIONS OR FINDINGS:

1. Violation of 320 IAC 4-6 (40 CFR 265):

   The inspection of this facility revealed total noncompliance with all of 40 CFR 265, with the exception of 40 CFR 265.14. (Any federal action should also cite 40 CFR 270 as permitting violations.)

RECOMMENDED ORDER OR RESOLUTION:

1. That the facility be compelled to develop written closure and post-closure care plans within sixty (60) days of receipt of the Order and submit it for approval. These plans must include all of the applicable requirements of 40 CFR 265, Subpart G, and 40 CFR 265.310 (320 IAC 4.1-28-4 and 320 IAC 4.1-21).

2. That within sixty (60) days of approval of the closure and post-closure care plans, closure shall be implemented in accordance with the approved plan.

3. That a civil penalty be assessed.

OTHER RECOMMENDATIONS AND REMARKS:

U.S. EPA may wish to issue a request for information under Section 3007 to obtain manifests for waste disposed of at Gary Development by U.S.S. Lead Refinery, Inc. U.S.S. Lead did not voluntarily produce those manifests at our request. Copies of manifests obtained from American Chemical Service, Inc., are attached.

ATTACHMENTS AND DOCUMENTATION

Part A
Groundwater study
Correspondence
Manifests
Trip Report

TLR/tr
10/17/85

Stat. Form 4336

STATE BOARD OF HEALTH

INDIANAPOLIS

OFFICE MEMORANDUM

DATE: February 6, 1986

TO: Stuart C. Miller
Facility Inspection Section-North

THRU: Karyl K. Schmidt KS 2-7
Dan B. Magoun 2/10

FROM: Richard T. Jones 2/6/86
Geology Section

SUBJECT: Soil Borings and Observations
at Gary Land Development, Lake County

RECEIVED
FEB 14 1986
U.S. EPA
WASTE MANAGEMENT
HAZARDOUS WASTE ENF.
BRANCH

"Complainant's Exhibit No. 13"

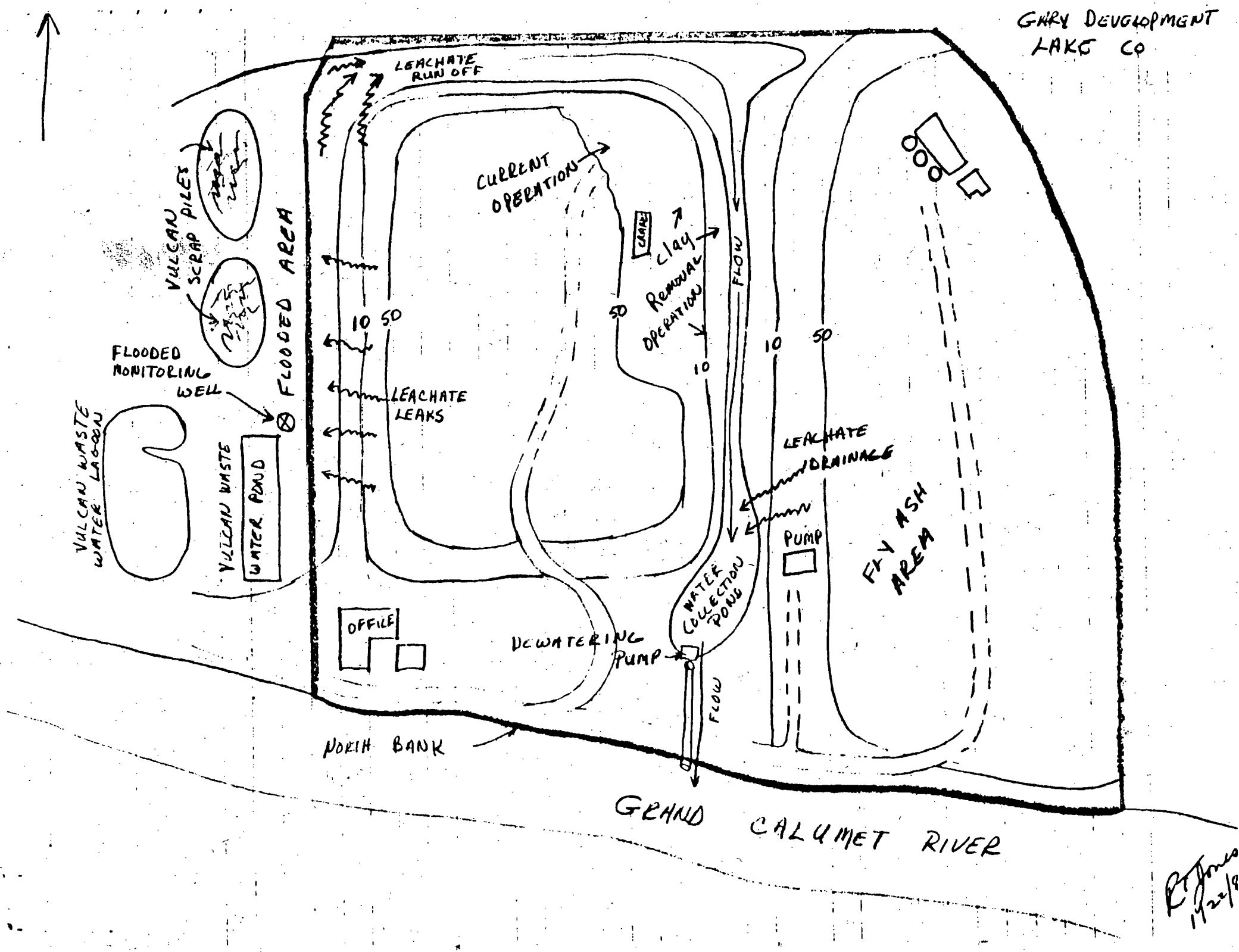
On December 16, 1985, Messrs. Duane Leith, Steve Schaefer, and I visited Gary Land Development. We walked the entire site and observed many leachate leaks. The west wall had several small leachate leaks which drained into a flooded ditch between Gary Land Development and Vulcan Recycling Company. The leaks occurred in the wall where proper clay thickness was in question. The responsible party, Mr. Larry Hagen, claimed to have six to ten feet of clay. However, their soil borings through the west wall indicate only two and one-half feet of clay. The soil boring conditions have not been met according to the court order. Additional information is needed concerning soil boring logs and testing results. The monitoring well on the west side was under water and needs to be raised or have the water drained away. It is not usable left as it is. (See diagram.)

Outside the north wall between the landfill and the railroad tracks is more drainage runoff which may be from the Vulcan Recycling Company, but runs onto the Gary Land Development property. This drainage may contain some chemical parameters that are toxic or above standard (as the monitoring well samples are). A drainage ditch bisects the landfill site and appears to be pumped into the Grand Calumet River. Per a phone conversation between Duane Leith and Joseph Krieger of Water Pollution Control on January 7, 1986, they do not have a permit. There is also leachate rapidly flowing into the ditch from the eastern bank. (See diagram.) I recommend leachate samples be taken around the site and from the drainage ditch which appears to have some oily film on the water.

The clay being used for the cover is removed from the drainage ditch which appears to complicate their drainage problems. Even with the best engineering plan properly executed, this site would be questionable geologically due to the shallow aquifer and poor drainage system, and the proximity to the Grand Calumet River.

RTJ/kp
cc: Ms. Pat Vogtman, U.S. EPA, Region V
Mr. Duane Leith
Mr. Steve Schafer
bcc: Mr. John Cooper

GARY DEVELOPMENT
LAKE CO



R T Jones
11/22/8

Cooper

"Complainant's Exhibit No. 14"

5HE-12

3 MAR 1986

David D. Lamm, Director
Division of Land Pollution Control
Indiana State Board of Health
1330 West Michigan Street
Indianapolis, Indiana 46206

Re: RCRA 3008(a)(2) Notice
Gary Development Company, Inc.
IND 077 005 916

Dear Mr. Lamm:

We have reviewed your October 22, 1985, hazardous waste enforcement referral package for Gary Development Company, Inc. Pursuant to Section 3008(a)(2) of the Resource Conservation and Recovery Act, as amended (RCRA), I am providing notice to you that the United States Environmental Protection Agency is preparing to issue an Order under Section 3008(a)(1) of RCRA to the subject facility for the violations outlined in the referral.

If you have any questions on this matter, please contact Mr. Jonathan Cooper of my staff at (312) 886-4464.

Sincerely,

William H. Miner, Chief
Hazardous Waste Enforcement Branch

bcc: P. Vogtman, SWB
H. Cho, SWB

	TYPIST	AUTHOR	OTHER STAFF	UNIT CHIEF	SECT. SECTY	SECT. CHIEF	BRANCH CHIEF
INITIAL DATE	3/4/86	3/11/86		3/11/86	3/12/86	3/12/86	3/12/86

5HE-12:JC:nd:6-4464:3/4/86

STATE BOARD OF HEALTH

INDIANAPOLIS

OFFICE MEMORANDUM

DATE: April 18, 1986

TO: RCRA Groundwater File
Gary Land Development Company, IND 077005916

THRU: Karyl K. Schmidt KS 4/21/86
Thomas L. Russell TR 4/23/86

FROM: Timothy J. Miller TJM 4/18/86
Geology Section

"Complainant's Exhibit No. 15"

SUBJECT: RCRA Groundwater Monitoring

After reviewing the most recent groundwater sampling results dated February 12, 1986, and November 6, 1985, it is still evident that the Gary Land Development Company is in noncompliance in regards to the RCRA groundwater sampling program.

Since November 1981, the Gary Land Development Company has been required to sample for the RCRA parameters (the National Primary Drinking Water Standards, ~~the four~~ 4 indicators of groundwater contamination, and the indicators of groundwater quality) and they have failed to do so. This case has been referred to the U.S. EPA, Region V, for enforcement action.

TJM/kp
Attachments
cc: Ms. Pat Vogtman, U.S. EPA, Region V (attachments)

Supervisor KS

Date 4/4/86

Record Review Form

Groundwater Data from RCRA Facility

1. Name of Facility Gary Land Development Co.
2. ID No. IND 077005916
3. Reviewer Timothy J. Miller
4. Date samples taken 11-6-85 & 2-6-86
5. Date report rec'd by State 11-21-85 & 2-20-86
6. Date reviewed 3/10/86
7. Type of data: (1stQ) (2ndQ) 3rdQ 4thQ SA A Annual report of 19__ of non-RCRA parameters
8. Quarterly Samples

	Y	N	Comments
A. Were samples analyzed for the following:			
i) Drinking Water Supply parameters;		X	
ii) Groundwater Quality parameters; or		X	Some, were analyzed for Iron, Chlorides
iii) Indicator parameters?		X	only pH (1 set)
a. For each indicator parameter, were at least four replicate measurements obtained at each upgradient well?		X	only 1 set
b. Were pH and specific conductivity tested in the field?		X	
B. For each well, were any parameters whose concentrations or values exceeded the maximum contaminant levels allowed in drinking water supplies separately identified?		X	
i) If so, which ones?			
C. Were initial background concentrations of the 30 parameters submitted to the Technical Secretary within 15 days after completing each quarterly analysis?		X	

Record Review Form

	Y	N	Comments
F. If in an assessment program, was annual report sent to the Technical Secretary containing the results of the groundwater quality assesment program?			
i) Did the report include the calculated (or measured) rate of migration of hazardous waste or constituents in the groundwater during the year?			

✓ * Fill out and attach State Summary Tables and ~~calculation of statistics.~~ Circle all values that exceed MCL's. ~~Note statistical differences.~~

✓ * Fill out and attach CMEL log. Return complete package to Supervisor.

* If violations, prepare and attach appropriate enforcement referrals.

Doc Id 0047G

Letter to RCRA Groundwater File (I-F)
thru enforcement

EPA Identifier IND 077005916

Gary Land Development Co
Gary, IN
LAKE CO.

RESULTS OF GROUND-WATER MONITORING

AFTER THE FIRST YEAR

Figure 9-3

Figure 9-3 (con't)

EPA Identifier IND 077005916

Person to contact about data: Larry Hagen

Telephone number:

Number of wells reported:

Upgradient

Downgradient

Total 4

Sampling Dates (Month, Year): 2/6/86 2nd Qtr

11/6/85 1st Qtr

Name and address of laboratory performing analyses:

LAKE Co Health Dept.

2293 N. Main St.

Crown Point, IN 46307

EPA Identifier TND [redacted] 070005916 Sample Date: 2/6/86

PARAMETERS USED AS INDICATORS OF GROUND-WATER CONTAMINATION

Upgradient vs Downgradient Unknown

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # North Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # South Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.2						7.3						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													
COD (mg/l)	368						1789						
Calcium Hardness (mg/l)	349.4						434.4						
TDS (mg/l)	1192						1862						

PARAMETERS USED AS INDICATORS OF GROUNDWATER CONTAMINATION

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # East Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # West Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.7						7.6						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													
COD (mg/l)	1067						19						
Calcium Hardness (mg/l)	252.2						1325						
TDS (mg/l)	1750						526						

O=>SDWS

Figure 9-3 (con't)

Identifier IND 077005916 Sampling Date: 2/6/86

PARAMETERS ESTABLISHING GROUND-WATER QUALITY

PARAMETER (UNIT)	Upgradient vs. Downgradient Unknown [redacted]				COMMENTS
	WELL # NORTH WATER ELEV. (ft) ___	WELL # SOUTH WATER ELEV. (ft) ___	WELL # EAST WATER ELEV. (ft) ___	WELL # WEST WATER ELEV. (ft) ___	
Chloride (mg/l)	20	102.2	63	84.3	
Iron (mg/l)	.16	.10	.08	(1.87)	
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

PARAMETER (UNIT)	[redacted]				COMMENTS
	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	
Chloride (mg/l)					
Iron (mg/l)					
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

" O = > SDWS

Figure 9-3 (cont)

PA Identifier IND 077005916 Sampling Date: 11-6-85

PARAMETERS ESTABLISHING GROUND-WATER QUALITY

PARAMETER (UNIT)	Upgradient vs. [redacted] Downgradient Unknown				COMMENTS
	WELL # NORTH WATER ELEV. (ft) ___	WELL # SOUTH WATER ELEV. (ft) ___	WELL # EAST WATER ELEV. (ft) ___	WELL # WEST WATER ELEV. (ft) ___	
Chloride (mg/l)	19.1	159.2	108.4	118.7	
Iron (mg/l)	.08	2.04	.27	65	
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

PARAMETER (UNIT)	[redacted]				COMMENTS
	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	
Chloride (mg/l)					
Iron (mg/l)					
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

O = > SDWS

Figure 3.3 (cont)

EPA Identifier IND 077005916 Sample Date: 11-6-85

PARAMETERS USED AS INDICATORS OF GROUND-WATER CONTAMINATION

Upgradient vs Downgradient Unknown

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # NORTH Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # SOUTH Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.2						6.6						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													

COD (mg/l) 342 — 91
Calcium Hardness (mg/l) 914.6 — 588.8
TDS (mg/l) 1,380 — 1,584

PARAMETERS USED AS INDICATORS OF GROUNDWATER CONTAMINATION

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # East Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # West Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.8						7.8						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													

COD (mg/l) 624 — 25
Calcium Hardness (mg/l) 217.4 — 194.8
TDS (mg/l) [illegible] — [illegible]

→ SDWS

IF Gary Land Development Co.
Lake County

Supervisor KS

Date 4/4/86

Record Review Form

Groundwater Data from RCRA Facility

1. Name of Facility Gary Land Development Co.
2. ID No. IND 077005916
3. Reviewer Timothy J. Miller
4. Date samples taken 11-6-85 & 2-6-86
5. Date report rec'd by State 11-21-85 & 2-20-86
6. Date reviewed 3/10/86
7. Type of data: (1stQ) (2ndQ) 3rdQ 4thQ SA A Annual report of 19__ of non-RCRA parameters
8. Quarterly Samples

	Y	N	Comments
A. Were samples analyzed for the following:			
i) Drinking Water Supply parameters;		X	
ii) Groundwater Quality parameters; or		X	Some, were analyzed for Iron, Chlorides [redacted]
iii) Indicator parameters?		X	only pH (1 set)
a. For each indicator parameter, were at least four replicate measurements obtained at each upgradient well?		X	only 1 set
b. Were pH and specific conductivity tested in the field?		X	
B. For each well, were any parameters whose concentrations or values exceeded the maximum contaminant levels allowed in drinking water supplies separately identified?		X	
i) If so, which ones?			
C. Were initial background concentrations of the 30 parameters submitted to the Technical Secretary within 15 days after completing each quarterly analysis?		X	

Record Review Form

	Y	N	Comments
F. If in an assessment program, was annual report sent to the Technical Secretary containing the results of the groundwater quality assesment program?	—	—	
i) Did the report include the calculated (or measured) rate of migration of hazardous waste or constituents in the groundwater during the year?	—	—	

✓ * Fill out and attach State Summary Tables and ~~calculation of statistics.~~ Circle all values that exceed MCL's. ~~Note statistical differences.~~

✓ * Fill out and attach CMEL log. Return complete package to Supervisor.

* If violations, prepare and attach appropriate enforcement referrals.

Doc Id 0047G

Letter to RCRA Groundwater File (I-F)
thru enforcement

IF Gary Land Development
Lake County

EPA Identifier IND 077005916

Gary Land Development Co
Gary, IN
LAKE CO.

RESULTS OF GROUND-WATER MONITORING

AFTER THE FIRST YEAR

Figure 9-3

Figure 9-3 (con't)

EPA Identifier IND 077005916

Person to contact about data: Larry Hagen

Telephone number:

Number of wells reported:

Upgradient

Downgradient

Total 4

Sampling Dates (Month, Year): 2/6/86 2nd Qtr

11/6/85 1st Qtr

Name and address of laboratory performing analyses:

LAKE Co Health Dept.

2293 N. Main St.

Crown Point, IN 46307

EPA Identifier 2ND [redacted] 07700059 16 Sample Date: 2/6/86

PARAMETERS USED AS INDICATORS OF GROUND-WATER CONTAMINATION

Upgradient vs Downgradient Unknown

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # North Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # South Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.2						7.3						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													
COD (mg/l)	368						1784						
Calcium Hardness (mg/l)	349.4						934.4						
TDS (mg/l)	1192						1862						

PARAMETERS USED AS INDICATORS OF GROUNDWATER CONTAMINATION

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # East Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # West Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.7						7.6						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													
COD (mg/l)	1067						19						
Calcium Hardness (mg/l)	232.2						1305						
TDS (mg/l)	1750						526						

O=>SDWS

Figure 9-3 (con't)

EPA Identifier IND 077005916 Sampling Date: 2/6/86

PARAMETERS ESTABLISHING GROUND-WATER QUALITY

PARAMETER (UNIT)	Upgradient vs. Downgradient Unknown				COMMENTS
	WELL # NORTH WATER ELEV. (ft) ___	WELL # SOUTH WATER ELEV. (ft) ___	WELL # EAST WATER ELEV. (ft) ___	WELL # WEST WATER ELEV. (ft) ___	
Chloride (mg/l)	20	102.2	63	84.3	
Iron (mg/l)	.16	.10	.08	(1.87)	
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

PARAMETER (UNIT)					COMMENTS
	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	
Chloride (mg/l)					
Iron (mg/l)					
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

( ) = > SDWS

Figure 9-3 (cont)

IPA Identifier IND 077000916 Sampling Date: 11-6-85

PARAMETERS ESTABLISHING GROUND-WATER QUALITY

PARAMETER (UNIT)	Upgradient [redacted] Downgradient Unknown				COMMENTS
	WELL # NORTH WATER ELEV. (ft) ___	WELL # SOUTH WATER ELEV. (ft) ___	WELL # EAST WATER ELEV. (ft) ___	WELL # WEST WATER ELEV. (ft) ___	
Chloride (mg/l)	19.1	139.2	108.4	118.7	
Iron (mg/l)	.03	2.04	.27	65	
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

PARAMETER (UNIT)	[redacted]				COMMENTS
	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	WELL # WATER ELEV. (ft) ___	
Chloride (mg/l)					
Iron (mg/l)					
Manganese (mg/l)					
Phenols (ug/l)					
Sodium (mg/l)					
Sulfate (mg/l)					

O = > SDWS

Figure 9-3 (con't)

EPA Identifier IND 077005916 Sample Date: 11-6-85

PARAMETERS USED AS INDICATORS OF GROUND-WATER CONTAMINATION

Upgradient vs Downgradient Unknown

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # NORTH Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # SOUTH Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.2						6.6						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													

COD (mg/l) 342 91
Calcium Hardness (mg/l) 314.6 588.8
TDS (mg/l) 681 1584

PARAMETERS USED AS INDICATORS OF GROUNDWATER CONTAMINATION

PARAMETER (UNIT)	Upgradient ____ Downgradient ____ Well # East Water Elev. (ft.) ____						Upgradient ____ Downgradient ____ Well # West Water Elev. (ft.) ____						COMMENTS
	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	Rep#1	Rep#2	Rep#3	Rep#4	Mean	Variance	
pH (pH units)	7.8						7.8						
Specific Conductance (umhos/cm)													
TOC (mg/l)													
TOX (ug/l)													

COD (mg/l) 624 25
~~Sulfate~~ Calcium Hardness (mg/l) 317.4 194.8
TDS (mg/l) 256.3 656

O = > SDWS

(COD.t)

IF Gary ... Lake Co

LAKE COUNTY HEALTH DEPARTMENT

LAKE COUNTY GOVERNMENT CENTER
2293 NORTH MAIN STREET
CROWN POINT, INDIANA 46307
PHONE: 738-2020 OR 663-0760

PEARL D. JOHNSON, M.D.
HEALTH COMMISSIONER

February 12, 1986

FEB 03 05 PM '86
DIVISION OF LAND POLLUTION CONTROL
STATE BOARD OF HEALTH

Gary Development Company
Box 6056
Gary, Indiana 46406

Attn: Mr. Larry Hagen

Given below are test data obtained from four samples of well water, which were delivered to this laboratory on February 6, 1986.

Sample	pH	Chloride	COD	Calcium Hardness	Total Iron	Total Dissolved Solids
North	7.2	20.0	368	349.4	0.16	1192
South	7.3	102.2	1184	934.4	0.10	1862
East	7.7	63.0	1067	232.2	0.08	1750
West	7.6	84.3	19	130.5	1.87	526

Note: Units of concentration for Chloride, COD, Hardness, Iron, and Dissolved Solids are parts-per-million.

Sincerely,

Cheryl A. Pauer

Cheryl A. Pauer
Chemist

Contact the EPA ...

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO THE ATTENTION OF

5CS-16

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

OCT 27 1986

Warren D. Krebs
Parr, Richey, Obremskey & Morton
121 Monument Circle
Suite 500
Indianapolis, IN 46204

"Complainant's Exhibit No. 16"

Re: Gary Development Company, Inc.
Docket No. RCRA V-W-86-R-45

Dear Mr. Krebs:

Since our settlement conference on August 4, 1986, U.S. EPA has gathered information which establishes the following:

1) LTV steel Company's temporary delisting applied only to its F006-type waste, not to K087. In 1981 alone, LTV transported at least 3,208,500 pounds of hazardous waste number K087 to Gary Development Company.

2) Between November 20, 1980 and January 21, 1983, U.S.S. Lead transported the following D008 (lead) hazardous wastes to Gary Development Company:
   - $CASO_4$ Sludge - 27 ppm lead, 762,480 gallons
   - Rubber Battery Chips - 6.1 ppm lead, 880 cubic yards
   - Reverb Slag - no analysis available, 220 cubic yards.

Based upon the above information, U.S. EPA believes that hazardous waste is present at the Gary Development Company facility. Therefore, the company must comply with the Complaint and Compliance Order issued May 30, 1986.

You may arrange another settlement conference by contacting myself at (312) 886-7948 or Jonathan Cooper at (312) 886-4464 within one week of your receipt of this letter.

Sincerely,

Marc M. Radell
Assistant Regional Counsel

STATE OF INDIANA

DEPARTMENT OF
ENVIRONMENTAL MANAGEMENT

INDIANAPOLIS, 46225

105 South Meridian Street

January 14, 1987

"Complainant's Exhibit No. 17"

Mr. William H. Miner, Chief
Hazardous Waste Enforcement Branch
U.S. Environmental Protectin Agency, Region V
230 South Dearborn Street
Chicago, IL 60604

Re: Gary Development Company, Inc.

Dear Mr. Miner:

Enclosed is a copy of the trip report for an inspection conducted at Gary Development on August 22, 1986, by Mr. Ted Warner of our Compliance Monitoring Section.

The owner/operator related that no changes had occurred since our June 17, 1985, inspection which resulted in an enforcement referral by the Department to U.S. EPA.

If you have any questions, feel free to contact me.

Very truly yours,

Thomas Russell

Thomas Russell, Chief
Enforcement Section
Hazardous Waste Management Branch
Solid and Hazardous Waste Management

TLR/eas
Enclosure
cc: Mr. Ted Warner
Ms. Sally Swanson
Mr. Garry Mills

State Form 4336

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

INDIANAPOLIS

OFFICE MEMORANDUM

DATE: November 17, 1986

TO: RCRA File

THRU: Dave Berrey DeB
Thomas Russell TR-11/21/6

FROM: Ted Warner DeB for TFW
Compliance Monitoring Section

SUBJECT: Scheduled Inspection at
Gary Development Company, Inc.
Gary, Indiana
IND 077005916

On August 22, 1986, I attempted to conduct a scheduled inspection at Gary Development Company, Inc. (GDCI), located at 479 North Kline Avenue, Gary, Indiana. The owner of this facility, Mr. Lawrence Hagen, was not present at the site. According to the gate operator, Mr. Hagen would not be available until later in the day.

I previously inspected this facility on June 17, 1985, with Mr. Thomas Russell, Chief of the Enforcement Section. At that time, Mr. Hagen informed us that he did not desire to operate a RCRA facility. He simply wanted out of the system (see my July 29, 1986 memo to GDCI RCRA file).

Later that day I telephoned Mr. Hagen. Mr. Hagen explained that nothing had changed at his facility from the date of my last inspection. Mr. Hagen informed me that he has not attempted to meet any applicable RCRA or 321 IAC 4.1 Regulation. He has had meetings with EPA representatives to try and resolve the matter.

In light of the position of Mr. Hagen regarding GDCI, my only action available is to resubmit the same enforcement referral used for the June 17, 1985, inspection.

TFW/rmw

cc: ~~Jim~~ Hunt
Tom Russell

1941.26 Background Document

261.24 - EP Toxicity Characteristic

"Complainant's Exhibit No. 18"

BACKGROUND DOCUMENT

RESOURCE CONSERVATION AND RECOVERY ACT

SUBTITLE C - HAZARDOUS WASTE MANAGEMENT

SECTION 3001 - IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

SECTION 261.24 - EP TOXICITY CHARACTERISTIC

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE

May 2, 1980

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I. Proposed Regulation

(1) Definition

A solid waste is a hazardous waste if, according to the methods specified in paragraph (2), the extract obtained from applying the Extraction Procedure (EP) cited below to a representative sample of the waste has concentrations of a contaminant that exceeds any of the following values:

Contaminant:	Extract level milligrams per liter
Arsenic	0.50
Barium	10.0
Cadmium	0.10
Chromium	0.50
Lead	0.50
Mercury	0.02
Selenium	0.10
Silver	0.50
Endrin (1,2,3,4,10,10-hexacloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethanonaphthalene)	0.002
Lindane (1,2,3,4,5,6 hexachlorocyclo hexane gamma isomer)	0.040
Methoxychlor (1,1,1-Trichloroethane) 2,2-bis (p-methoxypheny)	1.0
Toxaphene (C H CL - technical chlorinated camphene, 67-69 percent cholrine)	0.050
2,4-D, (2,4-Dichlorophenoxyacetic acid	1.0
2,4,5-TP (Silvex) (2,4,5-Trichlorophenoxypropionic acid	0.10

NOTE: - Extract levels specified for the above substances equal ten times the EPA National Interim Primary Drinking Water Standards for these substances. These standards are being revised. Extract levels specified above will be changed to reflect revisions to these atandards. Also, EPA is considering use of the Water Quality Criteria under the Clean Water Act as a basis for setting extract levels, in addition to the EPA National Interim Primary Drinking Water Standards.

(2) Identification Method

(i) Extraction procedure. (2) Identification method.
(A) Take a representative sample (minimum size 100 gms) of the waste to be tested and separate it into its component phases using either the filtration method or the centrifugation method described in this section.

Reserve the liquid fraction under refrigeration at 1-5°C (34-41°F) for use as described in paragraph (F) of this section.

(1) Filtration Method.

Equipment: Millipore YY22 142 30 filter holder (Millipore Corp., Beford, MA, 01730) equipped with an XX42 142 08 necessary 1.5 liter reservoir, or Nuclepore Corp., Pleasanton, CA 94566) equipped with a 1.5 liter reservoir, or equivalent filter holder.

Procedure: 1. Using the filter holder place a 0.45 micron filter membrane (Millipore type HAWP142, Nuclepore type 112007, or equivalent) on the support screen. On top of the membrane (upstream) place a prefilter (Millipore AP25124, Nuclepore P040, or equivalent). Secure filter holder as directed in manufacturer's instructions.

2. Fill the reservoir with the sample to be separated, pressurize to no more than 75 psi (7 kg/cm^2), and filter until no significant amount of fluid (o.5 ml) is released during a 30 minute period.

3. After liquid flow stops, depressurize and open the top of the reservoir, invert the filter unit, replace filter pads as in step 1. above, and resume filtering. Save pads for later use. Repeat this step until no more fluid can be removed from the waste at a pressure of 75 psi (7kg/cm2).

4. Take the solid material, and any pads used in filtration, and extract as described in paragraph (B). Subtract tare weights of filter pads in calculating the amount of solid material.

(2) Centrifugation Method

Equipment: Centrifuge (e.g. Damon-IEC catalog no. 7165, Damon-IEC Corp., Needham Heights, MA, or equivalent) equipped with a rotor for 600 ml to 1 liter containers (Damon-IEC catalog no. 976, or equivalent). For flammable material containing wastes, explosion proof equipment is recommended.

Procedure 1. Centrifuge sample for 30 minutes at 2300 rpm. Hold temperature at 20-40°C (68-104°F).

2. Using a ruler, measure the size of the liquid and solid layers, to the nearest mm (0.40 inch). Calcuate the liquid to solid ratio.

3. Repeat 1 and 2 above until the liquid: solid ratio calculated after two consecutive 30 minute centrifugations is within 3%.

4. Decant or siphon off the layers and extract the solid as described in paragraph B.

(B) Take the solid portion obtained in paragraph (i), and prepare it for extraction by either grinding it to pass through 9.5 mm (3/8) standard sieve or by subjecting it to the following structural integrity procedure.

STRUCTURAL INTEGRITY PROCEDURE

Equipment: Compaction tester having a 1.25 inch diameter hammer weighing 0.73 lbs. and having a free fall of 6 inches (Figure 1) (one suitable device is the Associated Design and Manufacturing Company, Alexdria, Va. 22314, catalog no. 125).

Procedure: 1. Fill the sample holder with the material to be tested. If the waste sample is a monolithic block, then cut out a representive sample from the block having the dimensions of a 1.3" dia. x 2.8" cylinder.

2. Place the sample holder into the Compaction Tester and apply 15 hammer blows to the sample.

3. Remove the now compacted sample holder and transfer it do the extraction apparatus for extraction.

(C) Take the solid material from paragraph (B), weight it and place it in an extractor. A suitable extractor will not only prevent stratification of sample and extraction fluid but also insure that all sample surfaces are continuously brought into contact with well mixed extraction fluid. When oprated at greater than or equal to 40 rpm, one suitable device is shown in figure 2 and available as Part No. 3736 produced by Associated Design and Mfg. Co., Alexandria, Va. 22314)

(D) Add to the extractor a weight of deionized water equal to 16 times the weight of solid material added to the extractor. This includes any water used in transferring the solid material to the extractor.

(E) Begin agitation and adjust the pH of the solution to 5.0+ 0.2 using 0.5N acetic acid. Hold the pH at 5.0+0.2 and continue agitation for 24+0.5 hours. If more than 4 ml of acid for each gm of solid is required to hold the pH at 5, then once 4 ml of acid per gm has been added, complete the 24 hour extraction without adding any additional acid. Maintain the extractant at 20-40°C (68-104°F) during extraction. It is recommended that a device such as the Type 45-A pH Controller manufactured by Chemtrix, Inc. Hillsboro, OR 97123, or equivalent, be used for controlling pH. If such a device is not available then the following manual procedure can be employed.

MANUAL pH ADJUSTMENT

1. Calibrate pH meter in accordance with manufacturer's specifications.

2. Add 0.5N acetic acid and adjust pH of solution to 5.0 + 0.2. If more than 4 ml of solution to 5.0 + 0.2. If more than 4 ml of acid for each gm of solid is required to hold the pH at 5, then once 4 ml of acid per gm has been added complete the 24 hour extraction without adding any additional acid. Maintain the extractant at 20-40°c (68-104° F) during extraction.

3. Manually adjust pH of solution at 15, 30, and 60 minute intervals moving to the next longer interval if the pH did not have to be adjusted more than 0.5 pH units since the previous adjustment.

4. Continue adjustment procedure for a period of not less than 6 hours.

5. Final pH after a 24 hour period must be within the range 4.9-5.2; unless 4 ml of acid per gram of solid has already been added.

6. If the conditions of 5 are not met, continue pH adjustment at approximately one hour intervals for a period of not less than 4 hours.

(F) At the end of the 24 hour extraction period, separate the material in the extractor into solid and liquid phases as in paragraph (A). Adjust the volume of the resulting liquid phase with deionized water so that its volume is 20 times that occupied by a quantity of water at 4° C equal in weight to the initial quantity of solid material charged to the extractor (e.g., for an initial weight of 1 gm, dilute to 20 ml). Combine this solution with the original liquid phase from paragraph (A). This combined liquid, and any precipitate which may later form, is the Extraction Procedure Extract.

(ii) Analysis - Analyses conducted to determine conformance with Section 250.13(b)(1) shall be made in accordance with the following or equivalent methods:

(A) Arsenic - Atomic Absorption Method, "Methods for Chemical Analysis of Water and Wastes," pp. 95-96, Environmental Protection Agency, Office of Technology Transfer, Washington, D. C. 20460, 1974.

(B) Barium - Atomic Absorption Method, "Standard Methods for the Examination of Water and Wastewater" latest edition, or Methods for Chemical Analysis of Water and Wastes, "pp. 97-98, Environmental Protection Agency, Office of Technology Transfer, Washington, D. C. 20460, 1974.

(C) Cadmium - Atomic Absorption Method, "Standard Methods for the Examination of Water and Wastewater", latest edition, or "Methods for Chemical Analysis of Water and Wastes". pp. 101-103, Environmental Protection Agency, Office of Technology Transfer, Washington, D. C. 20460, 1974.

(D) Chromium - Atomic Absorption Method, "Standard Methods for the Examination of Water and Wastewater", latest edition, or "Methods for Chemical Analysis of Water and Wastes", pp. 112-112, Environmental Protection Agency, Office of Technology Transter, Washington, D. C. 20460, 1974.

(E) Lead - Atomic Absorption Method, "Standard Methods for the Examinations of Water and Wastewater", latest edition, or "Methods for Chemical Analysis of Water and Wastes", pp. 112-113, Environmental Protection Agency, Office of Technology Transfer, Washington, D. C. 20460, 1974.

(F) Mercury - Flameless Atomic Absorption Method, "Methods for Chemical Analysis of Water and Wastes," pp. 118-126,, Environmental Protection Agency, Office of Technology Transfer, Washington, D. C. 20460.

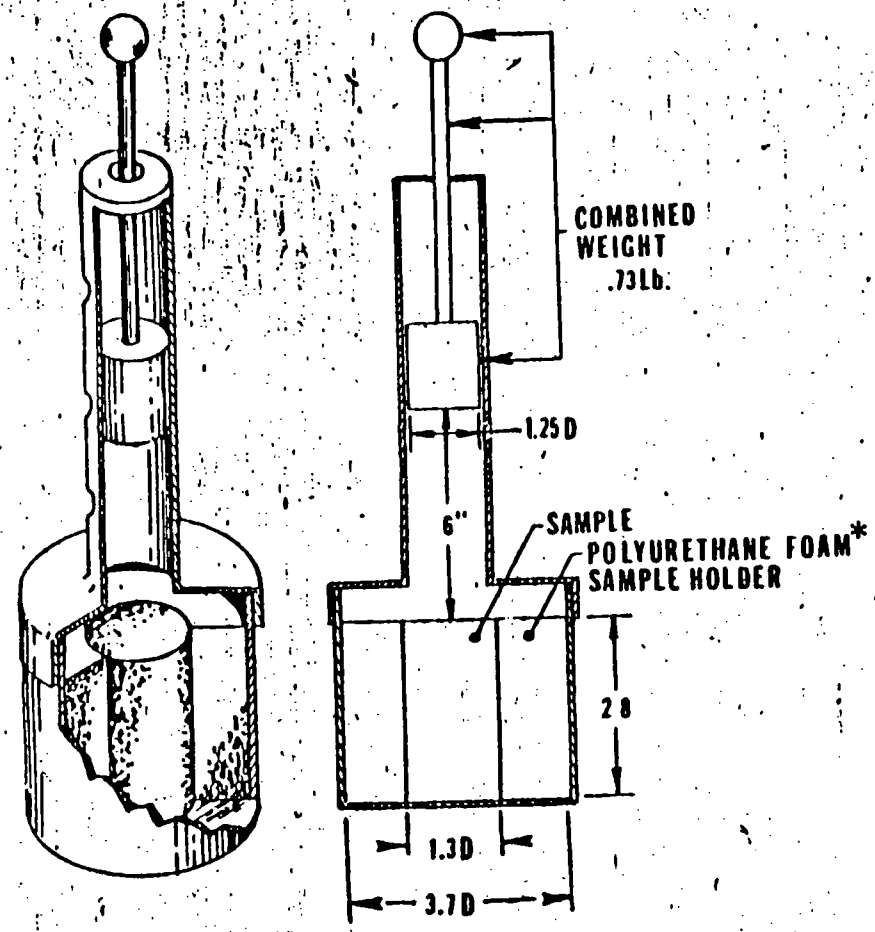
(G) Selenium - Atomic Absorption Method, "Methods for Chemical analysis of Water and Wastes," p. 145, Environmental Protection Agency, Office of Technology Transfer, Washington, D. C. 20460, 1974.

(H) Silver - Atomic Absorption Method, "Standard Method for the Examination of Water and Wastewater," latest edition, or Methods for Chemical Analysis of Water and Wastes", p. 146, Environmental Protection Agency, Office of Technology Transfer, Washington, D. C. 20460, 1974.

(I) Endrin, Lindane, Methoxychlor, or Toxaphene - as desribed in "Method for Organochlorine Pesticides in Industrial Effluents", MDOARI, Environmental Protection Agency, Cincinnati, Ohio, November 28, 1973.

(J) 2,4-D and 2,4,5-TP Silver-as described in "Methods for Chlorinated Phenoxy Acid Herbicides in Industrial Effluents," MDQARI, Environmental Protection Agency, Cincinnati, Ohio, November 28, 1973.

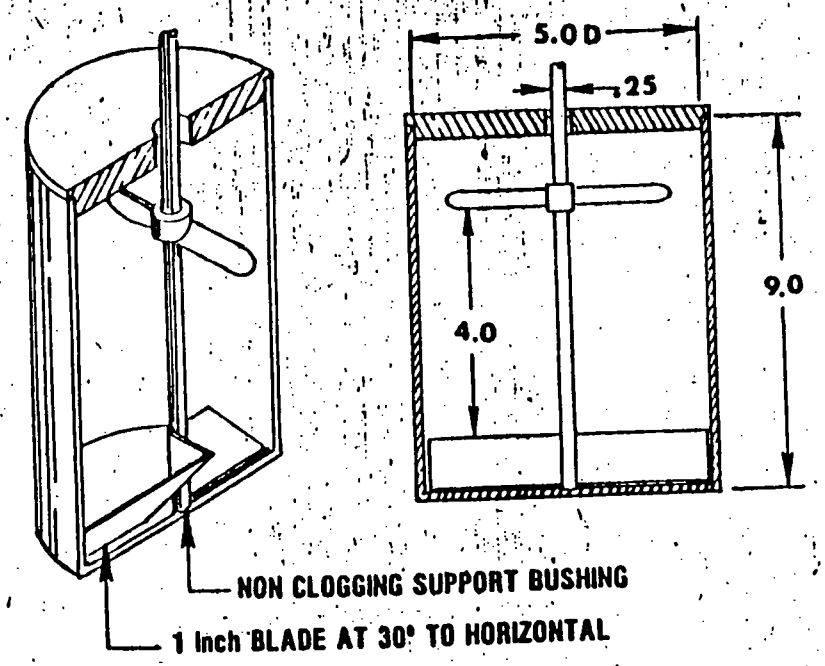
Figure 1



COMPACTION TESTER

*Polyurethane foam shall conform to requirements for Grade 21, performance Grade AD or BD, established in ASTM Standard D3453.

Figure 2



EXTRACTOR

II. DEVELOPMENT AND RATIONALE FOR THE CHARACTERISTIC

A. NEED FOR A TOXICITY CHARACTERISTIC

Subtitle C of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA) creates a regulatory framework for controlling the management of hazardous waste. Section 3001 of RCRA requires the U.S. Environmental Protection Agency (referred to herein as the Agency) to identify the characteristics of and to list hazardous wastes. Those wastes so identified are then included in the waste management control system set forth in Sections 3002 to 3006 and 3010 of RCRA.

This Background Document describes the process by which the Agency identified and defined one such characteristic, the "Extraction Procedure Toxicity Characteristic", and presents the rationale, assumptions, models, and scientific studies employed in defining the characteristic. This document also discusses the comments received on the proposed characteristic and the changes made in response to those comments.* For clarity the name for this characteristic has been changed from the proposed "Toxicity Characteristic to the Extraction Procedure Toxicity Characteristic in the final regulations.

---

*The distinction between a waste which is hazardous because it possesses the characteristic of toxicity, and a waste which is listed as hazardous because it meets the criteria of toxicity, is explained in detail in the background document on Identification and Listing of Hazardous Waste.

B. NATURE OF TOXICITY REGULATED UNDER THE SUBTITLE C REGULATIONS

Section 1004(5) of RCRA defines a hazardous waste as one that may:

(A) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or

(B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

The usual conception of "toxicity" certainly meets this standard.* Furthermore, section 3001(a) requires that toxicity be taken into account in determining which wastes are hazardous.

As used in these regulations, "toxicity" includes a wide range of hazardous effects. Acute toxicity upon exposure is one such effect. Toxicity is also used to encompass the specific properties of aquatic and mammalian chronic toxicity, carcinogenicity, mutagenicity, teratogenicity, and phytotoxicity. Another property of toxicity deemed of regulatory significance is the potential to bioaccumulate in animal tissue (see section 3001(a)). The following properties of toxicity are of particular regulatory concern:

---

*Webster's New Collegiate Dictionary, for example, indicates that toxic is synonomous with poisonous.

- serious harm to humans resulting from long term subacute exposure to chemicals released from the waste (i.e., death, incapacitation, cancer, birth defects, damage to future generations through changes in the gene pool);

- serious diminution of fishing resources resulting from contamination of surface water bodies; and

- serious harm to agricultural resources resulting from use of water contaminated by waste management practices for irrigation.

These choices are easily justifiable. In addition to the obvious need to regulate wastes which may result in death or incapacitation, wastes posing a threat of carcinogenicity are of special concern. Chemicals present in the environment, combined with dietary and societal influences, have been implicated in the high incidence of cancer in humans. In order to lessen human exposures to carcinogens, it is necessary to handle and dispose of wastes containing significant quantities of carcinogens in a manner appropriate for hazardous materials.

An additional danger from which society requires stringent protection is exposure to chemicals capable of damaging genetic material (i.e., mutagens). As a recent review in the American Chemical Society's Chemical and Engineering News stated:

> The relationship between mutagenicity and carcinogenicity debated by many, up to 90% of the chemicals so far tested and identified as mutagens in one or more short term tests are carcinogens as well.
>
> Cancer is only one consequence of genetic mutation, but the tragedy of its human dimension attracts public attention. Another potential serious threat from mutagens may lie in store for future generations:

> The insidious accumulation of subtle, irreversible mutations in the gene pool conceivably could have horrific consequences for the human race. By the time the effects of such mutations become apparant it'll be too late. (1)

Protection of the unborn fetus is another important goal of the hazardous waste program under RCRA. In order to lessen the likelihood of birth defects occurring as a consequence of improper management of waste materials, it is important to identify and regulate management of wastes containing teratogenic substances.

Protection of fishing resources is also an important goal of the hazardous waste program. Fishing is both a major source of income and food to many people and serves an important recreational purpose as well.

Congress cited several instances of fish kills in describing the types of substantial harm caused by hazardous waste mismanagement (2), indicating an intent to protect this resource from improper hazardous waste management. Furthermore, the Act requires the Agency to consider and protect not only "human health" but "the environment" in determining which wastes are hazardous (section 1004(5)).

Serious harm to fishing resources due to mismanagement of wastes can occur in two important ways. Discharge of toxic chemicals to waterways can result in the immediate death of large numbers of fish. This has occured many times during the past decade as a consequence, most notably, of transportation accidents. A second, more insidious threat,

is posed by long term, low level discharge of chemicals to surface water via groundwater transport. These chronic exposures can interfere with growth and reproduction, as well as cause death, and can lead to long term disappearence of aquatic resources of a water body. The Agency believes it is important to regulate wastes posing such a risk in order to safeguard this important national resource.

Protection of agricultural resources is an additional goal of the hazardous waste program, inasmuch as large amounts of ground and surface water are used in the United States for crop irrigation. According to the U.S. Geologic Survey,

> "The quantity of water withdrawn for irrigation in the United States, Puerto Rico, and the Virgin Islands in 1975 was estimated at 160 million acre-feet... This was an average rate of 140 billion gallons per day, and the water was used on approximately 54 million acres of farmland. This represents an increase in water use of about 10.9 percent over the 1970 estimate and an increase in acreage of about 9.4 percent."(3)

Plants often absorb harmful materials from their environment. It is therefore extremely important, given the critical importance of agriculture, that the sources of water available for irrigation be kept safe for this use. Furthermore, human exposure to waste contaminants may result from ingestion of food-chain crops exposed to contaminated water. Again, the threat to human health and the environment is plain, and warrants regulatory protection.

C. SCOPE OF THE TOXICITY CHARACTERISTIC

After identifying the various aspects of toxicity that are of concern, the Agency attempted to develop a definition for the "Extraction Procedure Toxicity Characteristic" which would encompass all of these aspects. Detailed discussions of the approach employed in attempting to develop such a broad characteristic have been detailed previously in materials made available to the public. (4,5,6,7)

However, the Agency was unsuccessful in developing such a definition. The EP Toxicity Characteristic promulgated today is limited to wastes which present a hazard to human health due to propensity to leach significant concentrations of those toxicants for which drinking water thresholds have been established. It should be noted, however, that although the EP Toxicity Characteristic regulates only those wastes containing toxic constituents for which National Interim Primary Drinking Water Standards (8) have been established, other wastes may still be regulated as toxic via the listing mechanisms under §§261.31 through 261.33 of the regulations.

(1) Aspects of Toxicity Outside the Scope of EP Toxicity Characteristic

(a) Chronic Toxicity of Wastes Containing Contaminants Other Than Those Included in the National Interim Primary Drinking Water Standards

In addition to the 14 substances for which National Interim Primary Drinking Water Standards have been established, there exist thousands of other chemicals which possess a significant toxicity. The Agency has wrestled unsuccessfully with the problem of setting definitional thresholds for these diverse potential toxicants. While one possible approach was outlined in the proposed Part 250.15 delisting requirements, adoption of this approach was found to suffer from a number of problems, principally the lack of a recognized means of setting a

threshold to measure these compounds' chronic toxicity. In addition, there is believed to be insufficient laboratory capacity to analyze generators' wastes or waste extracts for the thousands of toxic species involved. At the present time, therefore, only wastes containing the drinking water contaminants are within the scope of the characteristic.

(b) Carcinogenicity

A number of groups are active in identifying chemicals which are carcinogenic to humans. EPA's Cancer Assessment Group has taken the lead for the Agency in evaluating available information in order to determine which chemicals show substantial evidence of carcinogenicity.

The Cancer Assessment Group has evaluated the available information on a large number of such chemicals. They have concluded (10) that for approximately 150 compounds the information was sufficient for the compounds to be considered suspect human carcinogens.

This list was not made part of the self-regulating EP Toxicity Characteristic because of:

a. the lack of laboratory capacity to analyze all wastes for the presence and concentration of these compounds, and

b. the absence of the necessary dose-response and mobility relationships with which to derive general waste threshold levels which would withstand scientific challenge.

In addition to doing reasearch on methodology for specific compound identification and quantification, the Agency is conducting research to develop rapid, inexpensive biological screening methods to identify wastes containing carcinogenic materials. However, until such time as these methods are available, the Agency will identify specific carcinogen containing wastes through the listing mechanism.

c. Mutagenicity

There are a variety of mechanisms by which chemicals can act to cause damage to DNA. A program of waste control aimed at identifying and eliminating human exposure to such materials requires rapid, inexpensive procedures to pinpoint dangerous materials. In response to this problem, a number of rapid and potentially inexpensive bacterial and *in vitro* cellular tests have been developed. These tests are designed to identify mutagenic substances by detecting genetic damage in the test species. Because of the variety of types of DNA damage that are possible, no one test is sufficient to identify all mutagenic substances.

Although test procedures of this type are in general use for identifying potentially hazardous chemicals, the Agency has decided not to require their general use by the regulated community for two reasons:

(1) Research to date has not been sufficient to develop and validate experimental methodologies

for using these tests to evaluate the potential hazard posed by wastes;

(2) There is significant scientific uncertainty as to the degree to which such screening test results correlate with human toxicity.

There are currently a number of large scale programs being conducted to determine the applicability and validity of short term mutagenicity test systems. Foremost among these are the International Program for the Evaluation of Short-Term Tests for Carcinogenicity, the Genetox Program and the National Toxicology Program. The "International Program" is approximately three years old, while the other two programs have been underway for about two years and one year respectively. Detailed conclusions relative to the utility of short-term tests for mutagenicity are not yet available.

The Agency therefore has decided to postpone use of such tests pending the results of further studies. Wastes found to contain compounds posing a mutagenic threat to humans or the environment will be regulated through the listing mechanism.

d. Teratogenicity

There are at present no suitable testing methods capable of identifying teratogenic wastes. Consequently, in order to lessen the likelihood of birth defects occurring as a consequence of improper management of waste materials, the Agency will rely in the listing mechanism to reach such wastes.

e. Chronic Toxicity to Fish

The Agency encountered two problems in developing a toxicity test protocol for protection of fisheries resources. The first of these problems was the selection and development of a scenario to relate waste management to contamination of surface waters in which fish live. The second problem was in then establishing thresholds to determine what an unacceptable level of surface water contamination would be.

While a possible solution to the first of these problems (i.e., relating disposal to exposoure) was presented in the December 15, 1978 Draft Toxicity Background Document (6), the contamination model did not account for exposure occurring through either direct discharge or surface runoff. In addition to its incompleteness, the model suffered from the fact that the mixing zone dilution was not based on actual environmental data.

The second major problem relates to the unavailability of thresholds analogous to the drinking water standards. The Agency currently has a program underway to develop water quality guidelines. These guidelines will reflect the Agency's best scientific judgment as to maximum levels of toxic species in waters consistent with protection of the aquatic resources. However, until such time as these guidelines are available, the Agency does not believe it is in a position to complete development or propose a toxicity characteristic for protection

of fishery resources. Thus, identification of wastes posing a significant hazard to fish will be made using the listing mechanism.

f. Phytotoxicity

Besides not having threshold values to measure chronic exposure levels for fish, the Agency lacks threshold toxic exposure levels for plants as well. Thus, in order to protect against harm to agriculture resources, the listing mechanism will be used to bring phytotoxic wastes into the hazardous waste control system.

D. MAJOR POSTULATES CONTAINED IN THE CHARACTERISTIC

As noted above, the Extraction Procedure Toxicity Characteristic is limited to evaluation of the substantiality of hazard to human health posed by leachable waste constituents for which National Interim Primary Drinking Standards exist. The major postulates underlying the characteristic, and the reasons therefor are set out below.

1. Choice of Groundwater Exposure Pathway

For wastes defined as toxic by Section 1004(5), the hazard posed by a waste is dependent primarily on two factors:

a. the intrinsic toxic properties of the constituents in the waste (e.g., acute toxicity, chronic toxicity, genetic activity, bioaccumulation); and

b. the propensity of the constituents in the waste to migrate from the waste during management and result in environmental exposure.

The first factor, the intrinsic hazard, defines the actual health effect posed by the waste when exposure to the public or environment occurs. For the compounds identified in the characteristic promulgated today, sufficient toxicological information (i.e., National Interim Primary Drinking Water Standards) was available for EPA to determine not only intrinsic toxicity but safe exposure levels as well.

The second factor was not as well defined. That is, no test procedures were available to relate concentrations of toxic species in a waste to migration into the environment during waste management. Therefore, in order to develop the Extraction Procedure Toxicity Characteristic, the Agency found it necessary to develop a procedure to evaluate the propensity of a toxic material present in a waste to enter the environment and result in human exposure.

In considering the various exposure pathways of concern, the Agency concluded (not surprisingly) that the most probable ones were groundwater, surface water, and air. The groundwater pathway is believed to be the most serious for a number of reasons:

(1) Protection of groundwater from leachate contamination was one of Congress' principal objectives in enacting RCRA. (2)

(2) Groundwater serves as a source of drinking water for at least half of the propulation of the United States, and almost one-fifth obtains drinking water directly from groundwater wells. (11)

(3) Once contaminated, groundwater aquifers tend to remain contaminated for extended periods of time since their renewal times are very long.

(4) Groundwater aquifer contamination is difficult to detect, particularly in its early stages. Significant human exposure may thus occur before remedial action can be taken.

(5) Numerous incidents of groundwater contamination resulting from improper waste management have actually occurred.*

2. Choice of Particular Disposal Environment Model

a. Choice of Landfill Disposal

In considering the various forms of industrial waste management likely to occur which would lead to exposure via a

*The prevalence of the problem of groundwater contamination is illustrated by a 1977 study (12) of 50 land disposal sites that had received industrial wastes. At 13 sites, the study was able to obtain evidence that organic chemicals had migrated from the disposal site to groundwater, and that organic contamination of groundwater had occurred. Similarily, at 30 of the sites, inorganic contaminants were found to have migrated to groundwater. At 26 of these sites, hazardous inorganic constituents in the water at one or more monitoring wells was found to exceed the EPA drinking water limits. This study is but one indication of the potential for groundwater contamination posed by existing waste management. Other damage incidents are collected in open files of the EPA Office of Solid Waste, Hazardous and Industrial Waste Division, and are in the Subtitle C rulemaking record.

groundwater pathway (e.g., landfilling, land treatment, surface impounding, biological treatment), landfill disposal was believed to offer the greatest potential for mismanagement. The Agency reached this latter conclusion after considering the following factors:

(1) Land disposal of wastes results in the concentration of toxic species into a relatively small area,

(2) Concentrating waste into a small area results in the population exposed to toxicants emitted from the waste receiving a higher dose;

(3) Since the degree of harm posed by exposure to toxic chemicals is a function of the level of exposure, concentrating wastes into a small area is potentially more dangerous to human health and the environment;

(4) Leaching or leakage of toxic chemicals present in a waste disposed of in a landfill can result in contamination of potable groundwater supplies;

(5) Landfilling is believed to be the most prevalent waste disposal method and therefore the method most appropriate for modelling;

(6) The Agency believes that due to the lower cost of disposal, industrial waste not brought under Subtitle C control will likely be disposed of along with municipal trash and refuse in landfills.

The Agency thus concluded that since landfill disposal appeared to be the most common method of disposal and appeared to present a great potential for groundwater degradation, it would be the management scenario to model in these initial regulations.

b. Choice of Degree of Simulated Leaching Activity

1) The Leaching Simulation Test

After determining that the toxicity characteristic should evaluate the potential hazards posed by improper waste landfilling and subsequent environmental release via a groundwater exposure pathway, the Agency next had to decide how to measure wastes' potential to release hazardous constituents to groundwater under these circumstances, i.e., wastes' capacity to leach hazardous constituents if improperly landfilled. The key question thus became what degree of leaching activity the test should induce.

In devising this test, the Agency was guided by the statutory definition of hazardous waste, which commands implicitly that any test to determine hazardousness be aggressive, since all wastes potentially capable of causing substantial hazard if improperly managed are to be regulated as hazardous. At the same time, there must be some upward limit on the aggressiveness of a test, since virtually any substance can be hazardous if sufficiently mismanaged (for instance, dumped directly into a drinking water supply), yet the statute does not contemplate Subtitle C regulation of all wastes. The Agency thus determined that a test which simulates a degree

of leaching activity very unlikely to occur in most waste management practice is overly aggressive.

The leaching test, contained in the characteristic, known as the Extraction Procedure (EP), is designed to satisfy these competing considerations. As will be explained in greater detail below, the test assumes wastes will be exposed to an acidic leachate medium with pH of 5. This leachate medium tends to leach waste constituents (particularly metals) relatively aggressively, yet, as discussed below, is not so aggressive as to simulate a level of leaching activity beyond that which could realistically occur.

The choice of the leachate medium selected was premised on a specific physical model, which is described below. Importantly, however, the Agency believes that the predicted degree of contaminant concentrations in leachate could reasonably occur in the course of most waste management, whether or not the specific waste management conforms to this physical model.

The specific environment contemplated by the Agency in developing a leachate test is an improperly designed and managed municipal landfill. This type of landfill generally becomes acidic during its lifetime at which time the degree of leaching induced is relatively high.* The Agency's

*Specific features of this model are,
-- the landfill receives predominantly domestic refuse or, if not domestic refuse, material with similar chemical, biological, and toxicological properties (i.e., only 5% of the fill is industrial in nature).
-- the character of the leaching fluid that the waste will be exposed to is predominantly a function of the nonindustrial material in the landfill.

concern is that potentially hazardous wastes, if not brought within the Subtitle C system, may be sent to municipal landfills, with a resulting high level of leaching activity and environmental insult if the landfill was not designed specifically to prevent migration of leachate into the environment. This concern was shared by the Congress in promulgating Subtitle C:

> Even more threatening are the present disposal practices for hazardous waste ... In many instances these hazardous wastes are disposed of in the same manner and location as municipal refuse -- in the local landfill. H. Rep. No. 94-1491, supra, at 12.

These wastes' potential to cause harm in this environment therefore should be evaluated.*

2) Arguments That The Leaching Test is Overly Agressive

A great many comments were received attacking this portion of the characteristic as being overly aggressive because the commenters' wastes are not placed in municipal landfills. To the extent that these comments stated only that individual generators chose not to send their wastes to municipal landfills the comments are misplaced since the wastes may still potentially be managed in municipal landfills (absent Subtitle C regulation).

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*A specific discussion of how the leaching test simulates municipal landfill waste management conditions appears later in this document.

Certain generators,* however, stressed that their wastes are not managed in municipal landfills, and are highly unlikely ever to be so managed whether or not the wastes are regulated under subtitle C. The Agency remains convinced that the degree of contamination indicated by the EP is nevertheless sufficiently predictive of what may occur even in purely industrial waste management practice to be a regulatorily valid means of evaluating hazardousness of these wastes. First, even wastes such as these may reasonably come in contact with mildly acidic leaching media (i.e., pH of approximately 5) during their management histories. For example, waste acid streams are often disposed along with large volume waste streams. (13) Acid rainfall and water passing through acidic soils may be other sources of acidic leaching solution. Other wastes, although normally considered to be neutral or basic, may contain acidic constituents which can be released on contact with water or air to create acidic leaching conditions. Many mining wastes, for example, contain pyritic sulfur, which upon exposure to air and rain forms sulfuric acid, resulting in acidic leachate. Other types of improper

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*Among these generators are a number of large volume waste generators, such as electric utilities and mining wastes.

waste management may also result in exposure of waste to acidic leaching conditions.*

Furthermore, large volume wastes may cause an equivalent degree of contamination even if not subject to acidic leaching conditions. The large volume of waste present in the site tends to lead to increased toxicant concentrations. This effect comes about because the water (e.g., rain) acting on the waste travels through a larger amount of waste before entering the environment. The leachate thus tends to become saturated with the contaminants. By contrast, in municipal landfills, the small volume of industrial waste present limits the contact time in which toxicants can act to saturate the leachate.

The Agency therefore believes there is at least the potential for most wastes to come in contact with an acidic

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*A number of commenters agreed that their wastes could come in contact with acidic leachate media even though not managed in municipal landfills, but argued that the acidic leachate would be buffered (i.e., neutralized) to a greater degree than would acidic leachate in a municipal landfill, which would in turn result in a lesser degree of waste constituent solubilization. The degree of buffering in particular waste management settings is, however, very difficult to quantify, and the Agency believes its leachate test strikes a reasonable balance. The test in the first instance uses a relatively mild acid and further takes buffering capacity into account by limiting the amount of acid used in performing the extraction. In the case of wastes with high buffering capacities, therefore, the waste itself largely determines the leaching media composition. The degree of buffering predicted, while obviously not precisely accurate for every waste management situation, is believed to be sufficiently representative for use in the protocol.

leachate medium, or to cause equivalent degrees of contamination, so that the wastes' potential to cause harm if improperly managed can reasonably be measured by assuming the presence of acidic conditions. It should be noted further, that the Agency is not legally obliged to model precisely the circumstances of individual waste management sites, or classes of waste management sites, in making determinations of hazardousness. Not only does the statutory definition of hazardous waste itself afford the Administrator great leeway, but courts in other contexts have upheld national environmental standards based upon physical models which did not conform precisely to physical circumstances of affected facilities. See, e.g., Sierra Club v. EPA, 540 F.2d 1114, 1136 (D.C. Cir. 1976), vac. for further consideration in light of Clean Air Act Amendments of 1977, and to consider the suggestion of mootness, sub nom. Montana Power Co. v. EPA, 434 U.S. 809 (1977) (EPA's air pollutant diffusion model is upheld as a valid means of establishing emission standards for proposed new sources under prevention of significant deterioration regulations, even though the model is admittedly imprecise in predicting the effect new sources will have on ambient air, the court stating, "so long as the method of measurement is consistent, it may be used as a reliable benchmark of the relative impact of different sources"); State of Texas v. EPA, 499 F.2d 289, 301 (1974) cert. denied, 427 U.S. 905 (1975) (hydrocarbon emission reduction standard

established on the basis of a "simplistic" physical model is upheld; use of the model is not an arbitrary or capricious exercise of authority); Hercules, Inc. v. EPA, 598 F.2d 91, 104-106 (D.C. Cir. 1978) (toxic effluent standard for toxaphene established on the basis of toxaphene's effect on an aquatic species not found in the receiving waters of the sole discharger).*

It should also be mentioned that the phenomenon of leaching over the life of a waste management facility is incompletely understood, and can be characterized legitimately as "on the frontiers of scientific knowledge . . ." Industrial Union Department, AFL-CIO v. Hodgson, 499 F.2d 467, 474 (D.C. Cir. 1974). There is also no consensus within the scientific community as to an appropriate short-term extraction test to measure this phenomenon. Health-based regulations addressing such areas of uncertainty have traditionally been accorded considerable judicial deference. Hodgson, supra, 499 F.2d at 474-76; Ethyl Corp. v. EPA, 541 F.2d 1, 24-29 and cases there cited (D.C. Cir. 1976, en banc). Again, under these circumstances, some imprecision in the leaching test is not only acceptable, but eminently justifiable. As the court stated in Ethyl Corp., supra:

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*It should be noted further that in each of these cases, the physical model was used to establish a quantitative discharge standard, as compared to the present situation where a model is used only to make a screening determination of wastes which must be regulated to ensure proper management, a less precise undertaking. This situation is consequently a fortiori from the cited cases.

> Questions involving the environment are particularly prone to uncertainty. Technological man has altered his world in ways never before experienced or anticipated. The health effects of such alterations are often unknown, sometimes unknowable. While a concerned Congress has passed legislation providing for protection of the public health against gross environmental modifications, the regulators entrusted with the enforcement of such laws have not thereby been endowed with a prescience that removes all doubt from their decision making. Rather, speculation, conflicts in evidence, and theoretical extrapolation typify their every action. How else can they act, given a mandate to protect the public health but only a slight or nonexistent data base upon which to draw? Sometimes, of course, relatively certain proof of danger or harm from such modifications can be readily found. But, more commonly, reasonable medical concerns and theory long precede certainty. Yet the statutes--and common sense--demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable. Ethyl Corp., supra, 541 F.2d at 24-25.

3) Arguments That the Leaching Test is Insufficiently Aggressive

The Agency's proposed leaching test (and the EP Toxicity Characteristic as a whole) was also criticized as being insufficiently aggressive because the test was not "designed on the assumption that the waste will be disposed of in the worst possible environment."* As noted above, however, the Agency does not believe it is justified, nor is it advisable to base a determination of hazardousness upon waste mismanage-

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*Report on Hazardous Waste Disposal, Subcommittee on Oversight and Investigations of the House Committee on Interstate and Foreign Commerce, 96th Cong. 1st Sess. 53; see also Comments of Environmental Defense Fund, March 16, 1979, pp. 9-10.

ment assumptions -- including assumptions as to leachate medium composition -- which are very unlikely to occur in practice.

Moreover, it should be remembered that the Extraction Procedure Toxicity Characteristic (of which the leaching test is a part) is not the sole means of bringing solid wastes within the subtitle C regulatory framework. The other mechanism, listing of hazardous wastes, allows the Agency to interpret leachate data in a more individualized way, and to take into consideration additional factors, such as indications of actual waste mismanagement or unusual waste management practices, which are not measured by the characteristic.* Thus, the Agency has not ignored all waste mismanagement situations beyond the situation modeled in the toxicity characteristic; it has chosen to take them into account in a more individualized manner.

The Agency believes this course preferable to basing a test upon an assumption of absolute worst-case mismanagement. If a generator's waste fails the test, the waste is irrevocably within the subtitle C system. In the Agency's view, this requires some safeguard in the test against indiscriminate overinclusion, which overinclusion might result from a leaching

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*See, for example, Listing Background Documents for Chromium Pigments, Secondary Smelting and Refining of Lead, and Primary Smelting and Refining of Lead, all of which list wastes which conceivably might not fail the toxicity characteristic but still pose a substantial potential hazard because of the presence of additional factors not evaluated by the extraction procedure.

test based upon assumptions of unusually deficient waste management.* The Agency therefore chose what it regards as a plausibly-occurring type of mismanagement model on which to base its leaching test and toxicity characteristic.

c. Remaining Features of the Waste Disposal Model

Once a constituent is leached from the waste matrix, there remains the question of its environmental fate: does the constituent have sufficient mobility to pass through soils and reach groundwater, and if it reaches groundwater, is it persistent enough to reach environmental receptors in concentrations sufficient to create a potential substantial hazard. In evaluating these considerations, it is assumed that disposal will occur in an environmentally sensitive area, and that waste constituents will undergo some attenuation in both soil and groundwater before reaching environmental receptors. The postulated features of the hypothetical model which reflect these assumptions are:

-- The waste landfill is situated over an aquifer that serves as the sole source of drinking water for a significant number of people;

-- The soil below the site is composed of material with limited attenuative capacity;

-- Persons using the aquifer as a source of drinking water are being supplied from wells which are situated 150 meters (500 feet) downplume of the disposal site and draw water from the plume of contaminated water.

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*By contrast, a listing determination is not irrevocable since individual generators may petition the Administrator to have their waste delisted. See §261.39.

As is discussed later in this background document, a rate of leachate constituent attenuation is then projected based upon this model.

As with the leachate simulation test, a plausibly occurring type of worst-case mismanagement is assumed. With respect to the assumption that disposal occurs in an environmentally sensitive area, no other assumption would be warranted in light of the statutory mandate to protect against groundwater degradation (as well as to protect human health and the environment). Obviously, any characteristic must be designed not only to protect against mismanagement occurring in areas of relatively low mismanagement potential but also in areas of high potential. Indeed, the assumption of mismanagement in environmentally sensitive areas was not seriously challenged by any commenter.

The decision to take attenuation into account also appears to be both straightforward and desirable. There is clearly sufficient physical evidence of environmental attenuation for the Agency to assume that waste constituents will undergo some degree of attenuation before reaching environmental receptors. This type of approach has in fact been adopted by EPA in other environmental programs, with judicial acceptance. See, e.g., Hercules, Inc. v. EPA, supra, 598 F. 2d at 115-17 (mixing zone factor used in establishing toxic effluent discharge standard).

3. Thresholds to Determine Unacceptable Levels of Contamination

The final major assumption contained in the toxicity characteristic is the choice of thresholds to determine unacceptable levels of contamination. Obviously, if a test is used to measure toxicity, contaminant concentrations in the test extract need to be related to a numerical standard, viz., what concentrations of what contaminants give rise to a substantial potential hazard. For these values to be defensible, they should be based on recognized human exposure health effect thresholds.

When the Agency evaluated the available toxicological information it was found that the only available established benchmarks for toxic contamination of drinking water which were both scientifically recognized and which address chronic exposure were the National Interim Primary Drinking Water Standards (NIPDWS).* These standards were developed pursuant to §1412 of the Public Health Service Act as amended by the Safe Drinking Water Act to protect the nation's supply of potable water. They reflect the best available scientific information relative to safe levels for 14 potentially toxic species in drinking water.

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*The current approach used in the California hazardous waste program, which has been recommended as a model for the Federal regulations (see, e.g., Report on Hazardous Waste Disposal, supra, at 40), is not based upon contaminant thresholds, and thus provided no guidance in developing such thresholds.

The comment was made that the Agency should broaden the coverage of the Toxicity Characteristic by incorporating the "Water Quality Criteria" in addition to the Interim Primary Drinking Water Standards. As was described in the Proposed Regulation, this approach was initially considered but rejected. The principal reasons for not using the criteria are:

(1) The unavailability of the needed guidelines, and

(2) the lack of available resources in the regulated community to implement such an approach if adopted.

During the time regulations under section 3001 were being developed, Water Quality Criteria for the 65 pollutants listed as toxic under the Clean Water Act were first being formulated. The preliminary drafts then available received substantial negative comment from the scientific community, both from within and from outside the Agency. The Agency thus believed that it would be a long time before the final Water Quality Criteria were available, and further felt that it was inadvisable to delay proposal of RCRA regulations until the criteria were available.*

The second reason why use of the Water Quality Criteria

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*As it turned out, the first group of criteria were eventually proposed on March 15, 1979, a full three months after the RCRA section 3001 regulations were proposed. The last of the 65 were proposed on October 1, 1979. Final promulgation of the first group is presently scheduled for this summer.

was not believed to be viable relates to the insufficient scientific resources to implement such a regulatory approach. In order to implement a self-determinative regulatory program which requires generators to test all wastes for a list of toxic species, reliable, standardized testing protocols are required. Secondly, the regulated community has to have available to it sufficient testing capability (i.e., in-house or through contractors) to conduct the required tests. At the time the section 3001 regulations were proposed, and to a great extent still today, such reliable standardized methodology was not available. Furthermore, the personnel and laboratory facilities to perform the analyses that would be required under such a regulatory approach are not available.

In summary, the Agency believed the suggested approach (i.e., expand the characteristic by including threshholds for the 65 toxics for which Water Ouality Criteria are being developed) was impossible to carry out and thus the present listing approach was adopted. It should also be emphasized that the Agency may still bring into the hazardous waste control system any wastes that contain toxicologically significant quantities of any of the 65 toxicants for which Water Quality Criteria are being developed by listing specific waste streams. Many of the waste streams listed in today's Federal Register in fact are based upon the presence of many

of these 65 toxicants, as well as upon the presence of other toxicants not included within either the list of Water Quality Criteria pollutants or the pollutants measured by the Extraction Procedure Toxicity Characteristic.

the landfill interior, some components will be removed by adsorptive and complexing reactions, and others will be added by waste solubilization. At the interface between the landfill and the underlying strata, some further components may be removed by precipitation, filtration of particles, and absorption on gel precipitates. The existence below the landfill of an unsaturated zone with a liquid and a gas phase increases the possibility of attenuation or delay of contaminants. In this zone, permeability is lower than that of an all-liquid environment, and flow rates will probably not be uniform, thereby allowing some solute dispersion. Some insignificant attenuation by chemical or biochemical processes may also occur depending on the thickness of the unsaturated zone. (28)

At the boundary between the unsaturated and saturated zones, leachate movement changes from vertical to predominantly horizontal flow. This is in keeping with the fact that water entering the ground first moves vertically through the unsaturated zone then enters the saturated zone and travels in a hydraulic gradient. (28) Groundwater flow is normally laminar (i.e., characterized by parallel adjacent flow paths), although mixing can occur during movement through large fissures or in the immediate vicinity of a pumping well which alters the flow pattern of the groundwater. (29)

III. RATIONALE FOR THE EXTRACTION PROCEDURE

For purposes of easier comprehensibility of the following discussion, a description of the proposed Extraction Procedure (EP) is given at this point. The background document then goes on to decribe the genesis of the EP, the decision to use batch tests in the protocol, the issue of whether the test should be designed to measure maximum concentration or cumulative release of waste contaminants, and the physical justification for the various steps of the EP.

The proposed EP consisted of a series of steps. First a representative sample of the waste was obtained. The solid portion of the waste was then separated from the liquid portion by means of filtration and centrifugation. Next, the solid portion was ground, or subjected to a compaction force test for structural stability, and placed in an extractor where it was extracted with water acidified with acetic acid. This mixture was agitated and extracted for a period of 24 hours. At the end of the 24 hours the mixture was again filtered and the resulting liquid extract was combined with the liquid portion which was originally separated out. The combined extract was then analyzed for its constituent contaminants. If analysis revealed that the extract contained NIPDWS contaminants in concentrations greater than 10 times those specified in the National Interim Primary Drinking Water Standards, the waste was considered hazardous.

A. GENESIS OF THE EXTRATION PROCEDURE

When the Agency embarked on the devlopment of a testing

procedure to detect wastes capable of leaching toxic constituents into groundwater, there were no standard methods for measuring the leaching potential of a waste. For that matter, the processes governing the formation of leachate in landfills were only partially understood. Accordingly, EPA initiated two parallel research efforts to develop a standardized testing procedure to measure leaching potential. The first was a grant awarded to researchers at the University of Wisconsin in July 1976. This study, referred to hereafter as the Ham study, was commissioned to study the process of leachate generation from landfilled wastes, to evaluate the factors which influence leachate generation and to develop a leaching test suitable for assessing the leaching characteristics of such wastes. This study was completed in July 1978 and the results published in a May 1979 report entitled Background Study on the Development of a Standard Leaching Test (14).

The second research effort was a grant awarded to the Mitre Corporation to compile information on existing leaching tests and to evaluate the usefulness of these tests in assessing the leaching potential of a waste. Work on this grant was completed in February 1978, and the results published in a report entitled the Compilation and Evaluation of Leaching Test Methods (15). This report discussed the environmental factors which influence leachate generation and evaluated 26 different leaching tests for their utility in assessing the leaching characteristics of a waste. The Mitre report recommended that EPA single out for further evaluation the leaching test developed by IU Conversion Systems, the leaching test developed by the State

of Minnesota, and the leaching test being developed by Ham, et. al. at the University of Wisconsin. A study of these three tests was conducted by Ham as an adjunct to his other study and the results published in a July 1979 report entitled Comparison of Three Waste Leaching Tests (16).

While these studies were going on, EPA -- as a consequence of the time constraints mandated by Congress for promulgating the regulations --.entered into an agreement with the Department of Energy's Oak Ridge National Laboratory (ORNL) to conduct research into the toxicity of the extracts or leachates generated by the test procedure then under development by Ham. It soon became apparent that the extraction fluid developed by Ham was too toxic to permit its use in bioassay tests to determine whether toxic materials were leaching from the wastes. EPA was concerned because it wanted to be able to assess the toxicity of the waste leachate through bioassay procedures as well as through analytical detection of the leachate constituents.* [See the Draft Toxicity Background Document prepared in support of the proposed regulations.(6)] An additional concern with the Ham test was that it might be too site-specific.

Consequently, in the fall of 1977, EPA modified the agreement with ORNL to allow work to be performed in developing a leaching procedure suitable for use with bioassays (although still relatively agressive). Relying heavily on the work already done by Ham and Mitre and on the work done by other

*Although the finally promulgated test does not provide for bioassay tests on the waste extract, EPA envisions possible incorporation of such tests into the EP in the future.

groups, such as the American Society for Testing and Materials (ASTM), ORNL assisted the Agency in developing the Extraction Procedure set forth in the proposed regulations.

B. CHOICE OF A BATCH TEST

While a number of aspects of aspects about the EP, as finally proposed, were not settled until relatively late in the development process, some were settled early. As noted in the Ham study there are two general approaches to evaluating the leaching potential of a waste: (1) a very intensive study of the leaching characteristic of both the waste and its desposal or (2) a quick test using standardized procedures (14). Clearly, the intensive study -- which is very expensive and takes a great deal of time -- is unsuitable for use in the laboratory regime contemplated by the Act. Consequently, EPA decided early on to utilize a short-term standardized test as the device for assessing the leaching potential of a waste.

There are two types of short-term tests commonly used to assess the leaching potential of a waste: (1) batch or shake tests and (2) column tests. Batch tests are performed by placing a representative sample of the waste to be tested in a container along with the leaching solution. The mixture is then generally agitated for a specific period of time and the resulting elutriate or leachate separated from the remaining solid and analyzed for its constituents. Such tests are cheaper, faster and more reproducible than column tests,

but the test procedures must be carefully modeled upon actual landfill conditions if the information obtained is to be at all meaningful. Column tests are performed by placing the waste in a column and passing the leaching solution through. Such tests can give a better simulation of landfill conditions than batch tests. However, these tests suffer from a number of disadvantages, including:

--channeling and nonuniform packing

--unnatural clogging

--unnatural biological effects

--edge effects

--lengthy time requirements for running the test (months to years)

--lack of reproducibility (17).

In light of the above difficulties, particularly the lengthy time requirements for running column tests, EPA chose to employ a standardized batch test as the means for assessing waste leaching potential.

C. MAXIMUM CONCENTRATION VERSUS CUMULATIVE RELEASE

Ham considered it important for a leaching test to provide an indication of both the maximum concentration of toxic constituents likely to be attained in the leachate and the cumulative release of toxic constituents from the waste over time (14). EPA on the other hand, considers the maximum concentration of toxic constituents in the leachate to be the factor which primarily identifies the environmental hazard presented by the waste. This is because the concentration of

toxic constituents in the groundwater rather than the aggregate quantities released thereto determines the health hazard posed by groundwater contamination, although of course the two are related.

EPA also considers maximum concentration to be more important than cumulative release because of the lengthy residence time of contaminants in the groundwater. Unlike surface waters, groundwater is not continually flushing itself out; consequently, the aggregate contribution of pollutants is not as important as in surface water pollution. Accordingly, EPA has structured the EP so as to concentrate on the maximum concentration of contaminants in the leachate.

D. EXPLANATION OF HOW THE EP MODELS PHYSICAL FACTORS WHICH INFLUENCE LEACHATE FORMATION IN THE ASSUMED DISPOSAL ENVIRONMENT

The Extraction Procedure is designed to evaluate a waste's capacity to release hazardous constituents to the environment if the wastes are improperly landfilled in a plausibly occurring manner, and to gauge the resulting risk of substantial potential hazard. It thus becomes important to identify and replicate reasonably the principal physical processes and environmental factors influencing leachate formation and subsequent environmental contamination. These processes and factors include:

(1) Leaching medium composition;

(2) The amount of leachate medium to which the waste is exposed;

(3) Surface area, particle size, and composition of the material being leached;

(4) Contact time between the leachate medium and the waste and;

(5) Attenuative capacity of the soil and of the underlying aquifer.

The operative aspects of the extraction procedure (both the proposed and the final EP) -- i.e., the aspects of the procedure which model these factors -- are:

(1) Solid material particle size reduction;

(2) Phase separation;

(3) Leaching medium composition;

(4) Ratio of waste to extractant (solid-liquid ratio);

(5) Aggressiveness of agitation;

(6) Waste-extractant contact time;

(7) Assumed level of environmental attenuation.

A full discussion of the EP's component parts and how these parts relate to the physical processes which the EP attempts to model is set forth in the following pages.

1. Sample Preparation

a. Liquid-Solid Separation

Ham surmises that after a waste is deposited in a landfill the solid and liquid components of the waste will separate independent of any leaching action. (14) The liquid component of the waste might flow downward due to gravity, be absorbed by surrounding materials, or flow away from the waste by capillary action. After separation, only the solid material left behind will be subjected to leaching action by available leaching media.

EPA therefore believes that it is most appropriate to subject only the solid component of the waste to simulated leaching. Consequently, EPA has provided that the initial step in the EP is to separate the solid and liquid components of the waste. After extraction, the extract of the solid is combined with the original liquid phase of the waste to gauge the full extent of potential contamination posed by the waste.* This step models the situation

*EPA recognizes that the separation of liquid and solid components in the waste will depend on site-specific conditions, and so might not occur invariably. Nevertheless, it believes that utilization of the solid-liquid separation technique recommended by Ham is justified. The Agency, as stated, is attempting to model worst case conditions, and separating the phases prior to extraction of the solid phase is the more aggressive test. Secondly, under this approach liquid wastes would tend to be rated as more hazardous than solid wastes containing the same concentration of a given toxicant. This result is believed reasonable since liquids are more mobile than solids and would tend to migrate more rapidly, and in a more concentrated manner than solids.

where the liquid portion of the waste separates from the solid portion, flows downward and becomes absorbed onto other material in the fill. Later, leachate generated from the remaining solid migrates downward, displacing and mixing with the absorbed liquid phase and carrying it into the aquifer.

1) Sample Filtration

The Agency considered several techniques in performing the solid-liquid separation step, including filtration, sedimentation, centrifugation and screening. EPA considered filtration and centrifugation to be the most appropriate techniques and elected to make filtration the final step in the separation process, with centrifugation as a supplemental aid in separating wastes which cannot easily be separated by filtration alone.

The choice of a filter pore size has an important bearing on the ultimate concentration of toxic contaminants subjected to analysis, because the filter operationally defines both the liquid which is presumed to separate out from the waste and the leachate which is produced by the leaching process. In conformity with Ham's suggestion, EPA has selected a filter pore size of 0.45 microns because particles larger than 0.45 um are usually removed by passage through the soils, as indicated by the low suspended solids content of most groundwaters (14). It is therefore not unreasonable to assume that particles larger than .45 um will be filtered out by the soil and will not reach groundwater.

The separation procedure can be described as follows. If the sample is not obviously a solid, an attempt should be made to filter it through a 0.45 um filter under a pressure differential of $\leq$ 75 psi. If clogging occurs, centrifugation is employed as an aid to the separation. Pressure filtration acts to accelerate the filtration process without changing the nature of the separation. Centrifugation is particularly useful where the nature of the mixture is such that even pressure filtration would require a large expenditure of time. Although at the time of the proposal the Agency believed that centrifugation could be used as a direct replacement for filtration, later information indicates that using centrifugation alone results in a carryover of particles greater than 0.45 um. Consequently, the final regulation provides that centrifugation is only to be used as an aid to the filtration process. After centrifugation a final filtration must be performed to remove particles greater than 0.45 um from the liquid phase and remove residual liquid from the solid phase. Anything that cannot be readily separated by filtration and centrifugation is considered a solid and is subjected to the leaching aspect of the test.*

A number of commenters said they encountered severe operational problems running the extract procedure on

*Such wastes might include the thixotropic materials such as drilling muds and paints which were found to cause difficulty during evaluation of the separation procedure. (17,18). Since it is reasonable to assume that such wastes will not separate out in actual landfill conditions, such wastes should be treated as solids and extracted without separation.

liquid wastes which contain a very low percentage of solids (e.g., <1% solids). To accomodate this problem, EPA has elected to amend the proposed regulation to provide that a sample which contains less than 0.5% solids need not undergo the leaching procedure. Rather, such a sample, after filtration, should be considered the extract and should be analyzed directly for its toxic constituents. (Filtration is necessary because of the assumption that only particles less than 0.45 um in size will appear in the leachate.) This change will make the EP considerably easier to perform for liquid wastes with very low solids content, while not appreciably altering total concentrations of toxic constituents in the extract, since extractions performed on the small amounts of solid present in such solutions are not likely to generate much in the way of toxic contaminants.*

b. Sample Homogenization/Particle Size Reduction (Including the Structural Integrity Procedure)

To insure reproducibility of the leaching test performed on the solid portion of the waste, a homogenous portion is required.

*During evaluation of the separation procedure by Ham, ORNL, and EMSL-LV, very few operational problems were encountered, although one potentially serious problem has been noted by ORNL (6). Preliminary work indicates that the filtering of aqueous solutions containing polyaromatic hydrocarbons (PAH), using either Millipore, type HAWP, or Nuclepore, polycarbonate membrane filters, results in the solutions losing a substantial amount of their PAH content. If this effect is found to be the case generally for organics, it suggests that the non-polar toxicants may not show up in the extract in as large a concentration as they might in the real world. Unfortunately, the magnitude of the problem is not yet known and further work must be done before attempting to remedy the problem. If a solution turns out to be needed it will be incorporated into these regulations in the future.

This can best be accomplished by reducing the particle size of the waste through subdivision (e.g., grinding, cutting) -- a process which tends to equalize the surface area, geometry, and other such properties of the waste making up the sample. As a general matter, the more finely ground the waste, the more reproducible the test results are likely to be. At the same time, because grinding increases the surface are which comes into contact with the leaching medium, the finer the waste is ground, the higher the concentrations of contaminants in the extract.

It is difficult to gauge the extent to which reduction of waste particle size duplicates actual landfill conditions. The arguments that can be made on behalf of very fine grinding include the fact that wastes will eventually degrade in a landfill, and that fine grinding probably comes closest to representing the saturated conditions which occur when the leaching medium percolates slowly through a column of waste. However, very fine grinding tends to yield results which are probably not representative of wastes which have been treated for the purpose of reducing the mobility of the toxic species. A variety of these treatment processes have been developed -- including the incorporation of the waste into a solid matrix, the encapsulation of the waste in an impervious coating, and the addition of binders. These management techniques are designed expressly to prevent breakdown during disposal and need special consideration with regard to sample preparation.

To accomodate wastes which have been treated in an attempt to reduce the mobility of the toxic species or naturally are in a bound form, EPA has promulgated alternative sets of requirements. Wastes which have not been subjected to cementing processes or are otherwise not found in a monolithic or block form are required to be ground or otherwise subdivided such that they pass through a 9.5 mm (3/8 in) standard sieve. This requirement represents a compromise between the very fine grinding specified by the tests being developed by the states of Illinois (20) and California (21) and the use of a monolithic mass specified by ASTM (22) and IUCS (15).* Wastes which have been subjected to special encapsulation or fixing processes -- and are thus monolithic in form -- may instead be demonstrated to be structually stable and exempt from testing in a subdivided form through use of a special procedure called the Structural Integrity Procedure (SIP). The SIP is designed to be a moderately severe approximation of the disintegration that might be expected if heavy equipment passes over the waste.

Mahlock et al (23) have determined that a compaction test identical to the procedure of ASTM D-698-70, but using only 15 hammer blows, simulates the compactive effort that might be expected from passing earthmoving equipment over a placed landfill. Their

*A few commenters complained that the requirement of passage through a 9.5 mm sieve is insufficiently flexible because it fails to accomodate certain waste particles which fail to pass through the sieve yet exhibit a surface area equivalent to waste particles which do pass through the sieve. EPA has taken care of this problem by specifying that the waste either be passed through a 9.5 mm (3/8") sieve or have a surface area equal to or greater than 3.1 cm^2/gm.

15-blow test uses a (5.5-lb) hammer impacting on a (.0333 ft^3) cylinder of sample after dropping (12 in). This apparatus would exert an impact of (165 ft-lb/ft^3) on the sample:

$$v^2 = 2 \text{ (acceleration of gravity) (distance)}$$

$$= 2 \text{ (32.2 ft/sec}^2\text{) (1 ft)}$$

$$= 64.4 \text{ ft}^2/\text{sec}^2$$

$$\frac{\text{Kinetic energy}}{\text{volume of sample}} = \frac{1/2 \text{ m } v^2}{(1/30)}$$

$$= \frac{(.5) \quad (5.5/32) \quad (64.4)}{.0333}$$

$$= 165 \text{ ft-lb/ft}^3$$

EPA has decided to employ a modification of this procedure. The procedure selected is one based on a scaled down verion of Mahlock's 15-blow compaction procedure. The scaled down procedure uses a .32 Kg (0.73 lb) hammer acting on a (0.0022 ft^3) sample with a (6-in) free fall. This device (Figure 1) has approximately the same compaction action as the larger unit, as demonstrated by the equation below.

$$v^2 = 2 \text{ a x}$$

$$= (2) \text{ (32.2) (0.5)}$$

$$= 32.2$$

$$\frac{\text{Kinetic energy}}{\text{volume of sample}} = \frac{1/2 \text{ m } v^2}{(.0022)}$$

$$= \frac{(0.5) \quad (0.73/32) \quad (32.2)}{(.0022)}$$

$$= 165 \text{ ft lb/ft}^3$$

The sample size designated by this procedure will be approximately 100 gms, which corresponds nicely with the minimum sample size required for extraction. To account for the cushioning or energy dissipation resulting from the compressibility of surrounding wastes, a resilient sample holder has been incorporated in the design.

Weeter and Phillips (24) evaluated this procedure using a flue gas dusulfurization sludge fixated by the addition of varying amounts of water. Three samples were used in an attempt to represent a full range of unconfined compressive strengths.

Table 1

Sludge Sample No.	Density (lb/ft^3)	21 day UCS[a] (lb/in^2)
A	50	81
B	120	586
C	101	1450[a]

a Unconfined Compressive Strength

When subjected to a series of blows by the .32 Kg (0.73 lb) hammer, sample A cracked throughout the upper half of the cylinder, and the bottom half remained intact. The pulverized particles formed in the upper half of the cylinder seemed to dissipate much of the energy exerted by the hammer after the third or fourth blow. As a result, the succeeding blows had little effect on the remaining structure of the cylinder. No visible change in structure was noted in specimens B and C after the SIP procedure.

One shortcoming of the SIP as currently formulated is the lack of any measure of weatherability. Wastes deposited in or on the land will be subjected to the effects of water, freeze-thaw cycles, and seasonal and daily temperature changes. EPA intends to explore these factors to determine if a testing procedure can be devised which incorporates these additional factors.

2. Leaching Media Composition

It has been demonstrated empirically that the leaching media to which a waste is exposed, whether it be water, an acidic solution or whatever, has an important influence on the ultimate concentrations of toxic contaminants in the leachate. Consequently, the choice of a leaching medium (extractant) has an important bearing on the aggressiveness and ultimate shape of any leaching test.

As was explained previously in this document, EPA chose to model the leaching medium employed in the EP upon the leaching medium likely to be found in an actively decomposing municipal landfill. This was based on several considerations. First, given the considerable uncertainty and lack of information concerning the phenomenon of long term leaching, as well as its statutory mandate, the Agency believed it should be reasonably conservative in its choice of a leaching environment to model. Second, the Agency was convinced that most categories of waste have the potential of being disposed in municipal landfills. Third, the Agency believed that even wastes which are unlikely to be disposed of in municipal landfills are reasonably likely to come into contact

with a mildly acidic leaching medium at some point in their management histories. Finally, the level of leaching activity predicted could also occur even if acidic leachate was not present.

The following discussion explains how the composition of the extraction medium simulates leaching media which could be present in municipal landfill.

There is ample evidence that pH of the extracting solution is the most important factor in modeling an expected level of leaching activity relative to metal migration (14).* Further, the pH of the leaching media of a decomposing municipal landfill leachate will generally be acidic sometime during its lifetime, due to the presence of biodegrading refuse (14). The Agency therefore chose an acidic leachate composition, consisting of an acetic acid solution with a pH of 5.

Acetic acid was chosen because it is the most prevalent acid found in municipal landfill leachate (14). The pH value selected is well within the reported ranges of pH levels for municipal landfills, as shown in the following table:

*Other important factors include solution buffering capacity, complexing capacity, redox potential, organic solvency and ionic strength (14).

Table 2. pH RANGES REPORTED BY VARIOUS AUTHORS FROM LANDFILL OR LITERATURE SURVEYS (14)

Source	pH Range
Chian et al.	3.7 - 8.5
Steiner et al.	4.0 - 8.5
Clark et al.	1.5 a/ - 9.5
Encom Associates	3.0 - 8.5
Pohland	4.9 - 8.4

a/ Site received acidic industrial wastes.

Furthermore, the pH value selected promotes relatively aggressive leaching of elemental waste constituents, and so furthers the Agency's statutory mandate of protection of human health and the environment.

Another important physical feature influencing toxicant concentrations in leachate is buffering capacity. The ultimate buffering capacity of real world leachates is a consideration which has received little attention from the research community. Data gathered at EPA's Boone County Field Site (25) over a period of 7 years indicates that the leachate generated by decomposing municipal waste contains approximately 0.14 equivalents of acidity per kilogram of dry refuse. Applying this

data to the hypothetical disposal environment (containing 5% industrial waste and 95% organic refuse), EPA concluded that 1 gram of industrial waste could potentially be acted upon by approximatley 2 milliequivalents of acid. Translating this into the terms of the test, EPA determined that it should set a limit on total acid added to the extraction solution of 2.0 milliequivalents of acid per gram of solid material or 4 ml of 0.5 N acetic acid per gram of waste being extracted.

Certain other chemical parameters, notably extractant complexing capacity and redox potential, are not incorporated in the EP leaching medium (or are incorporated only to a limited degree). However, the Agency's failure to exactly replicate municipal landfill leachate is not necessarily a shortcoming. The ultimate regulatory objective is not to precisely model leachate from a municipal landfill, but to devise a protocol which is reasonably predictive of ultimate levels of leaching activity of a great variety of wastes. EPA believes that the present protocol largely achieves this objective relative to mobilization of metals and, to a limited extent, organics, and is thus promulgating the EP in the present form. EPA is studying this issue further, however, and if it appears that the protocol requires modifications in order to remain reasonably representative, appropriate revisions will be made.

The Agency is aware of one potentially serious regulatory deficiency in its choice of leachate medium composition. Studies performed by ORNL demonstrate that EPA's leaching solution (and Ham's synthetic solution) are deficient in their ability to adequately model the organic solubilizing ability of real world leaching media (7).* Since the characteristic is at present designed principally to evaluate leaching propensity of elemental,rather than organic contaminants, this deficiency is not deemed severe enough to warrant additional delay inplementing the characteristic. EPA is, however, working to develop a leaching media which reflects more accurately wastes' capacity to leach organic toxicants.

3. Sample to Extractant Ratio

The solid-liquid ratio, that is, the ratio of the quantity of solid waste to the quantity of leaching solution used, can be an important factor in assessing the leachability of a waste, since the greater the amount of waste present in the liquid, the more toxic species there are to be dissolved and the higher their concentration.**

*This is probably attributable to the failure of EPA's leaching solution and possibly Ham's as well to include species such as fatty acids, alcohols and humic acids which have a great deal of organic character (7).

**This dependency of concentration on solid-liquid ratio is particularly characteristic of species whose concentration is not controlled by a solubility equilibrium. On the other hand, where the concentration of the toxic species is controlled exclusively by solubility equilibrium, the concentration of the species will not vary with the solid-liquid ratio, although Ham's experience suggests that there are very few such species (14).

A high solid-liquid ratio is probably better representative of actual landfill conditions, inasmuch as the solid-liquid ratio encountered by a drop of leachate percolating through a landfill is likely to be very high. In addition, a high solid-liquid ratio is more likely to reflect the maximum attainable concentrations which are the principal focus of EPA's concern. At the same time, a high solid-liquid ratio can cause difficulties with stirring or separation and can cause the system to become saturated with readily soluble salts -- with the result that the less soluble but more toxic species are left behind in the waste. A low solid-liquid ratio will promote greater ease of operation but will tend to magnify sampling and analytical errors.

After considering the above factors, EPA has elected to use a 1:20 solid-liquid ratio. EPA believes this ratio will attain reasonably high concentrations while preserving operational precision. Furthermore the ratio selected is well within the bounds of the ratios used in other comparable leaching tests, as shown in the following table, and is therefore believed to be an acceptable value.

Table 3. SOLID - LIOUID RATIO LEVELS UTILIZED IN OTHER LEACHATE TESTS (15)

Test	Solid - Liquid Ratio
IUCS	1:4
University of Wisconsin Standard Leaching Test	1:10
State of Delaware	1:25
State of Minnesota	1:40

4. Agitation Methods, Number of Elutions, and Extraction Contact Time

Apart from the solid-liquid ratio, already discussed, the remaining parts of the EP which have the greatest bearing on the concentration of toxic constituents in the leachate are the agitation method, the number of elutions performed, and the contact time between leaching solution and the waste. These are discussed below.

a. Agitation Method

To ensure that the surface area of the waste is sufficiently exposed to the synthetic leaching solution to replicate the effects of a leaching medium percolating slowly through a landfill, and to ensure reproducibile results, it is important to employ a uniform, non-destructive, efficient agitation. Ham evaluated the following five agitation methods:

1. Continuous shaking (Gyrotory/Shaker, New Brunswick Scientific Co.)

2. Continuous mechanical paddle stirrring (Phipps and Bird, Inc. Richmond Va.)

3. Intermittent shaking by hand

4. Swing-type shaking

5. Rotating at two different angles

Ham concluded that none of these methods resulted in appreciably greater release of toxic constituents, although the rotating method gave the highest release. On the basis of the higher release figures for the rotating method and visual observtions which suggested that rotating at two different angles gave the best solid-liquid contact, Ham recommended use of the rotating method (14).

The Agency has, on its own, developed a stirring method which is useable with a wide variety of wastes and will permit the pH of the solution to be continuously monitored and adjusted using automated equipment. This device is illustrated in Figure 1 (see p.6). ORNL found that this device gave adequate agitation when rotational speeds greater than 40 rpm were employed. (7,19)

Rather than require use of this or any other particular equipment, EPA has decided, to simply specify that a suitable agitator or extractor is one which "will not only prevent stratification of sample and extraction fluid but also insure that all sample surfaces are continuously brought into contact

with well mixed extraction fluid." This is being done with the intention of providing the regulated community with the greatest flexibility in obtaining a suitable extractor. A number of commenters interpreted the proposed regulations to require that agitation be performed with a particular piece of equipment manufactured by the Associated Design and Manufacturing Co. (i.e., the equipment EPA employed in many of its own laboratory studies). This is not the case. The proposed regulation and the final regulation allow the use of any piece of equipment that meets the general objective of insuring sufficient agitation so that stratification of the sample and extractant fluid does not limit the extraction of potential contaminants. This will give the regulated community the greatest flexibility in the choice of extraction equipment.

Extractors other than the one developed by EPA have been developed for use in evaluating wastes. One additional device that deserves mention (26) (Figure 3) uses a simple jig to hold and rotate a number of jars containing samples of waste and extractant fluid. Other extractors or agitation devices are under study. The results of these evaluations will be made public as they become available.

b. Extraction Contact Time

Ideally waste should be kept in contact with the leaching solution long enough to insure that maximum concentrations of the toxic contaminants are obtained. Unfortunately, however, this is not always possible because small amounts

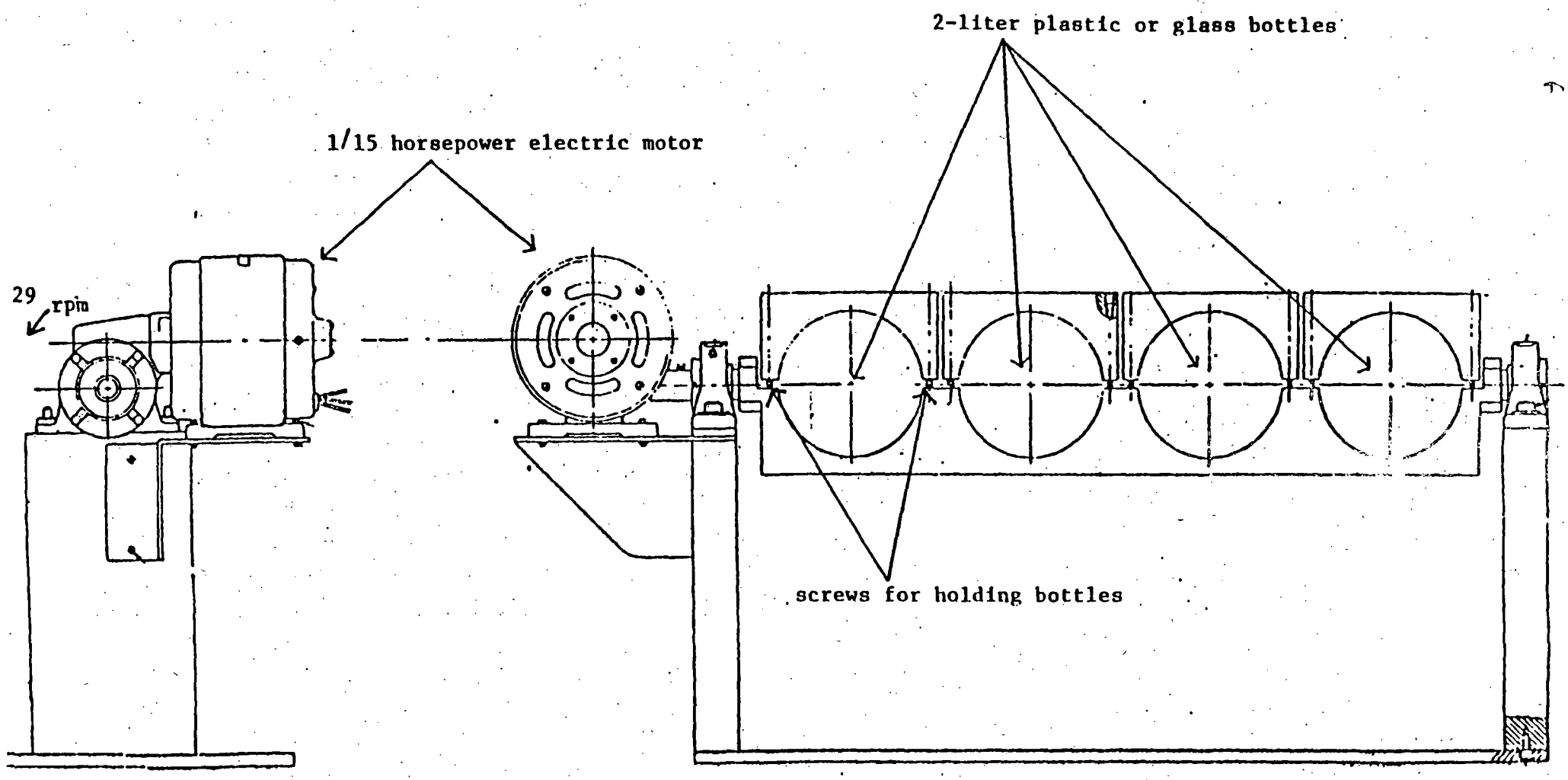

Figure 3
Rotary Extractor

of material may continue to leach from the waste for years.

Ham conducted research into the effects of elution time on cumulative contaminant release. He ran four elutions of varying duration on the waste--i.e., durations of 2 hours, 24 hours, 48 hours and 72 hours. After each elution, the liquid was filtered and analyzed for its constituents and the waste was contacted with an elution of fresh leaching solution. The results showed that cumulative release after three elutions is lower with a two hour contact time. For contact times over 24 hours the results were variable and in no instance were equilibrium conditions apparently reached. Ham suggested that a leaching contact time of between 24-72 hours be chosen, largely for practical considerations (14).

The Mitre survey indicates that there is no consensus among the available leaching tests as to the appropriate contact time required to simulate landfill conditions (15). This survey indicates that the contact times used in the various tests can be broken down as follows:

Less than 24 hours	- 39 percent
24 hours	- 39 percent
Longer than 24 hours	- 21 percent

In view of the above, EPA has chosen to employ a leaching contact time of 24 hours for the EP, based largely on practical considerations. The Ham research--although it dealt with the influence of contact time on cumulative release rather than maximum concentration--would appear to be applicable to maximum

concentration-oriented procedures in its conclusion that the effect of employing an elution time longer than 24 hours is inconsistent. Consequently, the Agency has chosen a 24 hour contact time to for the convenience of the laboratory personnel.

A number of comments were received in relation to the EP contact time. Some thought the time to be too long and others thought it to be too short. The Agency acknowledges that, in some instances, at extraction time of longer than 24 hours might yield more information. It also recognizes that in some instances a longer extraction contact time might result in a somewhat more conservative test. It believes, however, that concentrations obtained during the 24 hour contact time for one elution sufficiently approximates the maximum obtainable concentrations to justify selection of this figure.

c. Number of Elutions

Ham's procedure for measuring maximum concentrations of toxic contaminants in the leachate consists of running successive extractions or contacts of the same leaching solution on fresh waste. His study of this procedure showed that in some cases, steady state maximum concentrations were obtained after a very few extractions while in other cases steady state concentrations were not obtained even after 28 extractions performed over the course of eleven weeks. The most rapid increase in concentration occurred in the first extraction. Ham concluded that there is no ideal number

of extractions capable of generating maximum concentrations of all toxic species in the waste. Consequently, he recommended three contacts--primarily on the basis of practical considerations. (14)

EPA has determined that only one extraction need be performed for the EP. It recognizes that a greater number of contacts might result in higher concentrations. In the absence of any demonstration that one number is clearly better than another, however, and in view of the fact that the first contact gives the highest concentrations for any one elution, the Agency has elected to go the less conservative route and require only one extraction.

5. Post-Extraction Sample Handling

As noted above, EPA has made the assumption that the toxic species present in the liquid phase of the waste will migrate from the solid and eventually reach the underlying aquifer independent of any leaching action which takes place on the solid. In order to model this situation, the extract obtained from the solid phase of the waste is combined with the waste's original liquid phase prior to testing. While it usually is more convenient to analyze the combined liquids as one solution, in certain cases where a multiphasic mixture is obtained analysis may be more conveniently performed on the separate phases. In such situations the analytical results are mathematically combined, relative to the ratio of the phases, to determine the integrated Extraction Procedure

extract concentrations.

Once wastes are extracted, the extract should be preserved in order to prevent changes in the extract which might result in spurious analytical or bioassay results. When extracts are to be subjected to conventional chemical analysis only, the applicable preservation methods described in the EPA publication "Test Methods for Evaluating Solid Wastes" (27) are employed. In the event bioassay test are performed on the extracts, they should only be preserved by refrigeration at 4°C. This will prevent the introduction of potentially toxic preservatives. Irrespective of what sample preservation technique is employed, extracts should be analyzed as soon as possible after generation to prevent possible problems. One such problem relates to the formation of precipitates. In some cases the Agency has found that precipitates form when the extract sits for a period of time. While problems relating to precipitate formation are readily overcome when the extract is to be analyzed (i.e., through employment of the digestion procedures described in the test methods specified for use in evaluating solid wastes) (27), precipitate formation can present a problem when bioassay procedures are used. The Agency will be conducting further studies to determine the magnitude of these potential problems.

IV. BASIS FOR ATTENUATION FACTOR USED IN RELATING NATIONAL INTERIM PRIMARY DRINKING WATER STANDARD TO EP EXTRACT VALUES

The Extraction Procedure is designed to predict the potential concentrations of toxic constituents which will leach from the waste matrix itself. There remains the question of what will happen to the leachate after it leaves the waste matrix and before it reaches the point of environmental exposure. To accomodate the attenuation in concentration that can be expected to occur as the waste passes through the soil barrier beneath the landfill into the groundwater aquifer and ultimately to a drinking source, the Agency formulated a dilution factor designed to acccount for expected attenuation in groundwater. This attenuation or dilution factor was calculated against the backdrop of the following fairly conservative assumptions:

(1) The waste landfill is situated over an aquifer that is a source of drinking water;

(2) The soil below the site is composed of material with limited attenuative capacity; and

(3) Persons using the aquifer as a source of drinking water are supplied from wells situated 150 meters (500 feet) downgradient from the landfill.

The choice of an attenuation factor reflecting real-world conditions has proven to be one of the most difficult tasks faced by the Agency in formulating the EP Toxicity

Characteristic. Although the various attenuation mechanisms themselves are understood reasonably well, the actual rate of attenuation is highly site-specific. Moreover, there is very little empirical data on attenuation occurring during actual waste management, compounding the difficulty of generalization. Under these circumstances, it is the Agency's view that the choice of an attenuation factor is at the present time as much a question of regulatory policy -- i.e. what should the scope of coverage of the toxicity characteristic be -- as of regulatory judgment relative to the expected degree of attenuation that might occur during any specific type of waste management. The Agency believes its initial choice of a dilution factor of 10, and its final choice of an attenuation factor of 100 are both justifiable by reference to physical processes--that is, available data supports either choice. The discussion below sets forth the physical data bearing on attenuative mechanisms affecting constituent concentrations in leachate. The policy considerations which determined the Agency's decision to increase the proposed dilution factor are then described.

A. ATTENUATION OF CONSTITUENT CONCENTRATIONS IN LEACHATE

Changes in the composition of leachate from a landfill are usually achieved through a series of reactions. As the leachate migrates, constituent concentration may be affected by passage through various media. During percolation through

the landfill interior, some components will be removed by adsorptive and complexing reactions, and others will be added by waste solubilization. At the interface between the landfill and the underlying strata, some further components may be removed by precipitation, filtration of particles, and absorption on gel precipitates. The existence below the landfill of an unsaturated zone with a liquid and a gas phase increases the possibility of attenuation or delay of contaminants. In this zone, permeability is lower than that of an all-liquid environment, and flow rates will probably not be uniform, thereby allowing some solute dispersion. Some insignificant attenuation by chemical or biochemical processes may also occur depending on the thickness of the unsaturated zone. (28)

At the boundary between the unsaturated and saturated zones, leachate movement changes from vertical to predominantly horizontal flow. This is in keeping with the fact that water entering the ground first moves vertically through the unsaturated zone then enters the saturated zone and travels in a hydraulic gradient. (28) Groundwater flow is normally laminar (i.e., characterized by parallel adjacent flow paths), although mixing can occur during movement through large fissures or in the immediate vicinity of a pumping well which alters the flow pattern of the groundwater. (29)

Leachate does not mix readily with groundwater but tends to move as a slug, a plume, or a mass of degraded water in a manner governed by the groundwater flow pattern, although differences in density and miscibility can cause variation in behavior between the plume of contaminated water and native water. The velocity of this slug or plume of contaminated water may be less than, equal to, or greater than that of groundwater. (30)

Pollutants entrained in groundwater flow tend to become attenuated with time and distance. The attenuation mechanisms involved include dilution, adsorption, dispersion, diffusion, precipitation, and degradation. The most significant of these mechanisms in the saturated zone may be dilution of the leachate as it follows flow paths through the aquifer. The rate of attenuation will be dependent on the local hydrogeologic framework. Leachate will tend to be contained at sites underlaid by fine grained, compact materials with low hydraulic conductivities (slate, shale, soft clays). Migration with attenuation is favored in formations exhibiting intergranular flow (sands, sandstones, sandy clays, gravels) and formations displaying marked fissure flow with an element of intergranular storage (chalk) if the intergranular conductivity is greater than the maximum recharge rate. Rapid leachate

migration through coarse, unconsolidated gravel formations and fissured rocks such as limestone and granite allows little attenuation of pollutants. (30)

Where groundwater flow is rapid, leachate from a point source will form a long thin plume. Where groundwater flow is low, leachate may tend to disperse laterally. Distortion of the shape of the plume can also be caused by variations in permeability, the operation of a pumping well, and changes in the groundwater flow, recharge, and waste disposal rates, (which can cause the plume to expand or contract.) The plume of a leachate containing constituents having a greater susceptibility to attenuation will be smaller than that of one containing persistent contaminants. Additionally, a plume supported by constant input of leachate will ordinarily stabilize.

As can be seen from the above, the degree of pollutant attenuation within an aquifer basically depends on site-specific conditions; therefore it is impossible to choose a dilution factor that will be appropriate in all cases. While some sites may exhibit attenuations of 1,000-fold, others may show no attenuation at all. In some cases, with time, a site that originally exhibited a 1,000-fold attenuation may become saturated and begin to flush at the identical rate at which it is being charged.*

*A recent EPA - sponsored synposium on assessing attenuation likewise reached the conclusion that leachate attenuation is difficult to quantify outside of site-specific conditions. See "Pollution Prediction Techniques for Waste Disposal Siting, a State-of-the-Art Assessment" (31)

The Agency has utilized mathematical models in formulating an attenuation factor for regulatory use (32). A mathematical model is a simplified representation of a real system, and while difficulties are often encountered in quantifying parameters and testing and verifying results under specific field conditions, the model can supply information on potential groundwater effects. A model to estimate leachate dilution in groundwater and downgradient well discharge has been devised at the Water Research Center of Medmenham Laboratory in England (33). This model also suggests that there may be a wide range of dilution factors even if only a relatively few variables are considered. The model is based on the following assumptions:

1. Leachate of consistent composition is discharged from the entire landfill at a constant rate. (Lehr, Jay; Combined Media Report (34).

2. There is no chemical change in the leachate as it migrates through the aquifer.

3. The unsaturated zone is considered a delay mechanism only.

4. In the saturated zone, the aquifer is uniform and the natural groundwater gradient is constant.

5. Steady-state conditions exist.

This model calculates dilution factors using the following equation:

$$C\ (\text{ground water}) = \frac{IC(\text{leachate})}{I + (UB/L)}$$

where:

C = pollutant concentration

I = leachate infiltration rate

U = groundwater flow rate

B = depth of mixing

L = length of landfill in the direction of groundwater flow (35)

With the use of this equation, assuming average aquifer characteristics and a constant leachate production rate of 0.3 m/annum, dilution factors were calculated for three types of aquifers (Table 4). Results are given below:

Table 4 Dilution Factors For Three Types of Aquifers

Aquifer	Distance from landfill 50meters (164 ft)	300 meters (984 ft)
Chalk	15 - 50	100 - 250
Sandstone	3 - 10	15 - 50
Gravel	100 - 200	200 - 500

The lowest dilution factor obtained by these calculations (3x) was for a contaminant migrating through a sandstone aquifer beneath a landfill 50 m long. A well directly downgradient from the landfill would thus be expected to contain water (landfill leachate) exhibiting this degree of attenuation Any additional dilution that may occur would depend on how fast water was withdrawn from the well. If high pumping rates were employed water from outside the plume might be drawn into the well thus diluting the contaminated water (33).

Existing empirical data (and there is not a great deal) likewise indicates considerable variability in pollutant dilution factors in groundwater. The behavior of chloride graphically illustrates this. The chloride ion is a highly mobile and persistent contaminant. It is readily leached from waste and is resistant to ion exchange, chemical reactions and adsorption. Attenuation of chloride during migration is due to dispersion and dilution. Some observed dilution factors for chloride at various distances from waste disposal sites are listed in Table 5.

TABLE 5. Chloride Dilution Factors (14)

Site	Distance	Dilution Factors
Illinois landfill	650 ft.	4-5
Llangollen, Delaware landfill	650 ft.	27
Connecticut landfill	200 ft.	2
Fly ash settling pond	500 ft.	8-9
DuPage County, Illinois landfill	32 ft.	2
Winnetka, Illinois landfill	800 ft.	13
Tythegston landfill, England	330 ft.	2-3

Attenuation factors for hazardous constituents of leachate also vary widely. Table 6 illustrates data from field analyses of several waste disposal sites.

TABLE 6 - Pollutant Attenuation Factors (14)

Site	Pollutant	From Disposal Site Distance	Attenuation Factor
Iowa landfill	Arsenic	400 ft.	12 - 13
Fly ash settling pond	Arsenic	500 ft.	4
Kings Kettle landfill, England	Cyanide	430 ft.	50
Coatham Stob landfill England	Chromium	500 ft.	100
Mitco	Phenol	adjacent	>23
Mitco	Nickel	adjacent	>170
Mitco	Phenol	adjacent	>1000
Mitco	Zinc	adjacent	>14

The results illustrate the current rudimentary understanding of leachate attenuation and the difficulty in arriving at a dilution factor which reasonably reflects the dilution in concentration from the point at which the contaminated leachate leaves the disposal site to the point of human or environmental exposure. In sum, there exist no widely accepted criteria for gauging this diminution in concentration.

B. EPA'S CHOICE OF AN ATTENUATION FACTOR

In the proposed regulation, EPA chose a dilution factor of 10 as a conservative, but reasonable figure. EPA based

this dilution factor on (1) the figures computed from the mathematical model--figures which incorporated EPA's original assumptions of no attenuation between waste matrix and groundwater aquifer, and, (2) the empirical analyses of attenuation experienced at actual landfill sites. EPA does not believe that this factor of 10 represented the minimal level of dilution that could be expected. For instance, leachate migrating from a disposal site in Islip, New York was not attenuated by that amount until it had migrated 805 meters (0.5 mile)(28). It did, however, believe that a dilution factor of 10 provided a reasonable degree of protection to the public health and the environment while at the same time acknowledging the broad range of hydrogeological conditions at waste disposal sites across the country and the variety of contaminants likely to be released.

A large number of comments were received concerning the proposed dilution factor. Most argued that the factor of 10 was arbitrary and far too conservative. Others argued that the factor of 10 was not conservative enough and that only a factor of zero would ensure adequate protection to public health and the environment.

EPA has carefully reevaluated its original choice of a 10-fold dilution factor and has decided that a 100-fold dilution factor would be more appropriate. A number of considerations have motivated EPA to make this alteration.

Probably the most important consideration is the relative absence of empirical data upon which to base an attenuation factor, and strong suggestions that choice of any of a wide range of attenuation levels could be supported by what data is available. This absence of empirical data is particularly troubling because the dilution factor plays an exceptionally important role in defining the breadth of the EP's coverage.

A second consideration involves a shift in current regulatory strategy. The EP was initially viewed as the principal mechanism for bringing hazardous wastes into the Subtitle C regulatory system. However, when it proved impossible to develop suitable characteristics for carcinogenicity and other aspects of toxicity, (see pp. 12-18 above), the Agency decided, at least for the present, to use the listing mechanism as the chief means of coverage. The overall scope of coverage of the EP thus became somewhat less critical, and a less conservative attenuation factor more appropriate (particularly since the listing mechanism encompasses wastes containing EP contaminants).

Another consideration is the absence of a variance procedure for wastes which exhibit the property of EP Toxicity (i.e., wastes which fail the EP are conclusively deemed to be hazardous). The effects of a waste being anomalously brought into the system by the EP are greatly aggravated by

this lack of a variance procedure, thus dictating the need for some caution.

A further consideration is that the EP is a necessarily less precise instrument than the flexible listing procedure for determining whether a waste which straddles the line is in fact hazardous. For instance, the EP fails to take into account the quantity of a waste generated--a factor which could make a difference in determining whether a marginally hazardous waste belongs in the system or out. Similarly, the EP fails to take into account mismanagement scenarios specific to the waste which might argue for including the waste in the system even though it passed the EP. Consequently, EPA believed that marginal determinations of hazard might better be entrusted to the listing mechanism.

EPA is also concerned that its assumption of zero soil attenuation may have been unduly conservative, since soil attenuation may play a role in many waste management situations. A decision to take soil attenuation into account also suggests some need to increase the attenuation factor.

EPA has therefore decided to adopt a 100-fold factor. It is convinced that waste which fails the EP at the 100-fold factor has the potential to present a substantial hazard, regardless of the waste's management circumstance, so that coverage will certainly not be over-inclusive. In order to bring into the system wastes which present a potential substantial

hazard but do not fail the EP at the 100-fold dilution factor, EPA has listed and will continue to list wastes which do not fail the EP at this 100-fold factor. Its adoption of the 100-fold factor will thus shift to the listing mechanism some of the burden for capturing wastes containing EP contaminants.

EPA emphasizes that the change to the 100-fold dilution factor is provisional. If forthcoming studies demonstrate that another attenuation factor is more appropriate, EPA will switch to that factor. In taking the cautionary step of moving to the 100-fold factor, EPA recognizes it is empowered to forge ahead in the face of scientific uncertainty. By the same token, however, it is empowered to act cautiously--especially when there is another means (here the listing mechanism) of accomplishing its goal.

The Agency is cognizant of the fact that for four of the organochlorine compounds for which thresholds have been established, the threshold exceeds the published water solubility for the compounds. However, the Agency does not believe this presents a problem.

The primary purpose of the EP Toxicity Characteristic is to identify manufacturing or process wastes containing leachable contaminants in toxicologically significant levels. When present in process wastes or as formulated products, the compounds are normally present in admixture with other organic

compounds which tend to act as cosolvents to increase the apparant water solubility. Thus the Agency believes that the water solubility is not a true measure of potential solubility in the EP extract.

A second factor leading the Agency to conclude that this potential problem may not be a serious one relates to the specific pesticides involved. Several of them enjoy only limited use and thus are unlikely to actually be present in any significant number of wastes.

However, the Agency is studying this apparant problem and if it is determined that corrective action is needed, such changes will be incorporated into future revisions of the regulations.

V. RESPONSE TO COMMENTS RECEIVED ON THE PROPOSAL AND ON THE NOTICED REPORTS

A. Adopt Existing Regulations

The Agency received several comments questioning EPA's need to develop a new method of identifying toxic wastes since there are already a number of states with regulations which address this problem. These states include Washington (39), California (40), and Minnesota (41). Some commenters specifically suggested that EPA model the Federal regulations on the California and Washington regulations.

The Agency believes that the hazard posed by a waste is primarily dependent both on the intrinsic toxic properties of the waste constituents and the propensity of constituents in the waste to migrate from the waste to the point of environmental exposure. Except in the case of direct discharge to sewers or surface water bodies, contamination of ground and surface water appears to be a function of not just what is in the waste, but also the likelihood of the toxic constituents migrating from the point of disposal. Therefore, in formulating its leaching test, the Agency has attempted to comprehensively incorporate into the test consideration of the waste's migration (i.e., leaching) potential. Inasmuch as many of the outstganding state regulations fail to give consideration to migration potential, EPA has not adopted their approaches in constructing the EP.

EPA has, however, to some extent based its listing approach

states whose regulatory approaches most resemble EPA's in this regard are Minnesota and California. In both the Minnesota and California approaches, wastes are considered to be hazardous based on the presence in the waste of a designated toxic specie (40,41). In the Minnesota regulations, the waste must contain a given concentration of the toxic species. In the California regulations, the mere presence of any one of a long list of chemical species is presumed to make the waste hazardous, unless the generator proves otherwise. EPA's newly formulated criteria for listing come very close to incorporating this California approach. Under these criteria, the presence of a hazardous constituent is deemed to make the waste hazardous unless the Administrator, after considering any of a number of factors concludes that the waste is not hazardous. Most of these factors have a direct bearing on migration potential.

EPA has elected to adopt this approach in the Extraction Procedure Toxicity Characteristic in recognition of the differences between the two mechanisms. The EP Toxicity Characteristic is a one-shot mechanism for bringing wastes into the system; there is no opportunity for generators to present mitigating data nor is there any variance procedure. Consequently, it is incumbent on the Agency to fully incorporate consideration of migration potential into the test protocol accompanying the characteristic. The listing mechanism, on the other hand allows for some generator input into the

Agency's determination and is accompanied by a variance procedure. Consequently it is permissible to create what is in effect a presumption for listing based on the mere presence of the toxic constituent in the waste (as California does [40]), in view of the opportunities provided for subsequent consideration of migration potential and the opportunities for more individualized consideration of hazard.

B. Suitability of EP As a Regulatory Tool

A number of comments were received concerning the suitability of using the Extraction Procedure as a regulatory test. These comments, many of them similar, addressed the reproducibility, validity, accuracy, and scientific defensibility of the procedure. The comments came from all factions of the affected community including industry, government, environmentalists, academia and citizens in general.

The comments addressed one or more of the following five areas:

1. Appropriateness of using a single test procedure, based on a single model of assumed management, to determine the hazardous potential of wastes which are disposed of in a wide variety of disposal environments.

2. Acceptability of using for regulatory purposes a test procedure that has not been fully accepted by the scientific community.

3. Whether the EP is reproducible enough for it to be acceptable for regulatory use.

4. Accuracy of the Extraction Procedure.

5. Propriety of having a hazardous waste definition employ a test procedure which requires the exercise of scientific judgement.

1. Appropriateness of Using a Single Test, Based on a Single Model of Assumed Mismanagement, to Determine whether a Waste is Hazardous

The vast majority of comments revolved around the Agency's use of a single test procedure, based on a single model of assumed mismanagement, to determine whether a waste is hazardous. Many of these comments specifically questioned the appropriateness of the Agency's utilization of a co-disposal scenario. Others expressed the view that because they handle their waste in a manner very different from that described in the scenario on which the Extraction Procedure is modeled, the EP should not apply to them and a means should be given to permit them to disprove the results of the EP. Some commenters were especially critical of the Agency's use of one test to measure environmental mobility in light of the comments expressed by Ham et. al. (14,16). Some specific statements of Ham that were pointed to are:

"A standard leaching test provides a reproducible set of numbers that are a function of the interaction of waste with a specific leaching solution under a specific set of conditions. It is up to the decision maker to evaluate those numbers and make a prediction regarding the behavior of the waste in a landfill. Unfortunately, the multiplicity of factors affecting the leaching characteristics of a waste, both in the test and in the landfill, and the variability of landfill conditions, dictate that interpretation be done with care and with consideration of the waste and landfill characteristics. Test results should not be interpreted rigidly, e.g., developing criteria stating that a certain concentration of a given parameter in the test leachate automatically and without further consideration indicates that the waste is hazardous in the landfill. Rather, consideration should be given to such factors as the amount of waste to be disposed, the annual net infiltration of water in the area of the landfill, the factors affecting the leaching of the waste (as far as can be determined from the test results), possible waste-leachate interactions, and the fate of the landfill leachate after it leaves the waste and passes through wastes or soil."(16, p. 3,6)

"Because of the major differences in a waste's leaching characteristics as a result of the leaching media composition, no one media can give results adequate to describe properly the leaching characteristics of a waste." (14,p.2)

"The importance of using different leaching media was indicated by the results." . . . "Without the use of several leachates, test results could be very misleading and have no relation to the actual landfill for a particular waste." (16, p.2)

Proper interpretation of the results from the recommended procedure is critical to its usefulness. The test was designed to be aggressive; the numbers obtained are expected to be maximum values which will not be attained normally in an actual landfill." (14, p.3)

"Whatever standard test is used, interpretation of test results is the crucial factor in determining the test's ultimate value in predicting whether a waste is hazardous when placed in landfill. Virtually any leaching test which is properly interpreted would be more useful in making such a prediction than would be a well designed leaching test which is poorly interpreted." (16, p.7)

"Unfortunately, the multiplicity of factors effecting the leaching characteristics of a waste, both in the test and in the landfill, and the variability of landfill conditions dictate that interpretation be done with care and with consideration of the waste and landfill characteristics. Test results should not be interpreted rigidly, e.g., developing criteria stating that a certain concentration of a given parameter in the test leachate automatically and without further consideration indicates that the waste is hazardous in the landfill." (16, p.6)

"One obvious way to interpret the leachate composition results is to compare the concentrations of the various chemical species to some standard, for example, drinking water standards. This is dangerous, however, and is difficult to defend for the leaching test developed in this study." . . . "It was not designed to provide realistic concentrations of the various species for a specific situation." (14, 127)

"Thus, once a standard leaching test has been designed, interpration of the test results becomes a crucial factor in determining the applicability of the test." . . . "It is up to the decision maker to evaluate . . . and make a prediction regarding the behavior of the waste." (16, p. 3)

"It may be possible to correlate test conditions with landfill concentrations by running extensive verification tests, correlating a waste's behavior in the test with the behavior of the same waste in a carefully monitored landfill. Correlation coefficients could then be developed for parameters and conditions similar to those in the verification study and the test result used to estimate landfill concentration." (Background)(14, p. 124)

"There is a lack of data regarding leachate generation at fullscale industrial waste landfills with which results from the laboratory leaching procedure can be compared. Field verification studies are needed in which unattenuated and indiluted leachate from specific industrial wastes in mono- as well as co-landfill situations can be compared with appropriate leaching test results, preferably on a long term basis." (Background)(14, p.4)

As was discussed earlier in this document, EPA believes it has the authority to base the EP Toxicity Characteristic on a single plausibly-occurring scenario of mismanagement even if this mismanagement scenario does not precisely correspond to the circumstances of a particular generator's management practices. Those who quoted Ham on this point failed to appreciate that Ham's goals differed somewhat from the Agency's goals. Ham was interested in designing a test which, insofar as possible, evaluated the leachability of particular wastes as they are actually managed in particular landfill environments. Recognizing that the leachability of a waste, and thus its ability to cause a hazard, is a situation-specific phenomenon, Ham counseled caution in applying the results of the test to specific landfill situations. EPA, on the other hand, is not as interested in the leachability of a waste as it is <u>actually</u> managed as it is in the leachability of the waste under some plausibly-occurring mismanagement situation. Thus, while EPA recognizes that its test will not predict the leachability of particular wastes as they are actually managed,

it believes that its test is reasonably predicitve of the hazard which a waste could present if mismanaged. EPA has intentionally refrained from making its definition of hazard dependent on the actual management to which a waste is subjected, because it believes that the Act contemplates defining hazard in terms of some assumed level of improper management. Making the definition of hazard completely dependent on situation-specific management practices would have the effect of excluding from the hazardous waste management system those wastes which are properly managed, with a consequent sacrifice of the continuing oversight and assurance of proper management provided by the system.

The above does not, however, fully respond to those who argued that, in constructing its scenario of assumed mismanagement, EPA should to the extent possible take into account the actual mismanagement practices to which particular wastes are likely to be subjected. One of the principal comments along this line was that EPA should use a variety of leaching media in the EP to take into account the fact that many wastes are not likely to be disposed of in municipal landfills, even if improperly managed.

The Agency recognizes this concern but believes, as articulated in greater detail above, that the single leaching medium it has elected to employ, when considered in light of the other aspects of the test, is reasonably predictive of the the leachability of mismanaged wastes, even if those wastes are not disposed of in municipal landfills. The Agency also believes that its decision to employ a single model of improper management is

justified by concerns about the administrative feasibility of employing more sophisticated multiple models. In any event, to the extent the commenters are concerned that, by failing to tailor the model of improper management to specific management conditions, EPA is making its test too aggressive, these concerns are put to rest by EPA's switch to the 100-fold dilution factor. EPA is fully convinced that anything which fails the EP at the 100-fold factor has the potential to cause a hazard, no matter what leaching medium, etc., it is actually exposed to.

2. Acceptance by Scientific Community

A number of comments questioned the acceptability of using a test procedure which has not fully been accepted by the scientific community. Before addressing the acceptability of using a test procedure for regulatory purposes that has not been fully accepted by the "scientific community," one must first define what is meant by the "scientific community".

There are two groups making up membership in this community; those scientists working for industry, government, and other entities who will be directly affected by the regulations and scientists whose only interest is academic. The first group has a direct financial or institutional interest in seeking to exempt from the system waste(s) their organization or constituency generates. Obviously, these members of the regulated community are concerned with the economic implications of any test methodology employed in defining a hazardous waste. The second group of scientists are basically motivated by a desire to assist the Agency in developing regulations utilizing the "best" information that the scientific community possesses.

In the main, it was the regulated community that commented that methodology should receive scrutiny and acceptance by the "scientific community" prior to regulatory use. The Agency agrees with this comment. Toward this end, EPA developed the proposed test procedures in open view of all interested parties in hope that scientists would then

apply the procedures being developed to wastes of concern and, with the data so obtained, assist the Agency in correcting any problems with the proposed procedures. With few notable exceptions (35, 37, 42, 43) this did not happen. Scientists from the regulated community have, in the main, concerned themselves with trying to convince the Agency to modify the test procedures. Their goal was to make the test procedures less aggressive and, thus, less likely to identify their particular waste as a hazardous waste, rather than to determine if the procedures were scientifically valid (i.e., accurately identify wastes needing controlled management). Even though the Agency extended the comment period on March 12, 1979, for an additional sixty days (44 FR 13548)[44], industry did not submit significant amounts of data.

While many comments were received commenting on the invalidity of the test procedures, few commenters supplied the necessary scientific data to justify their concern. The chemical industry was especially unresponsive. Studies sponsored and conducted by the Agency(18,19), the Electric Power Research Institute(37), and others (35,36) have indicated that the Extraction Procedure is of acceptable reproducibility for regulatory use. Given the lack of convincing data to the contrary from the affected groups, the Agency has decided to employ the Extraction Procedure in the regulations being promlulgated today. If future research uncovers better test procedures for use in §3001 regulations, the regulations will be amended.

probably more germane to the issue of the adequacy of the EP and the analytical techniques. Third, the studies were not designed for comparison with other studies. Thus, even when results are presented on similar phenomena, e.g., the intra-laboratory reproducibility of analyses results for barium and chromium, the statistics reported are not always sufficient to make good comparisons. For example, some of the studies (19,18) use coefficients of variations (the same as the relative standard deviations, RSD) to indicate the degree of variability in the measures, while others (36) use a relative standard error (RSE). Thus, when the specific means and standard deviations are not reported, it is not possible to calculate uniform measures of reproducibility that can be used across studies.

Fourth, none of the studies were designed to focus specifically on the questions of reproducibility. The exception might be the complex design in the study conducted by the Electric Power Research Institute (37), but the use of geometric analyses makes the study incompatible with research results in the other studies. Also, no interpretation of the results from this study (37) are offered in the report which was available. Along this line also, none of the studies presented data on analytical technique reproducibility for all of the toxic metals included in these regulations. This leaves open the question of whether different levels of reproducibility are characteristic of different toxic metals. This limitation is important because it cannot be assumed that the analytical precision of measures on one element could be equally precise for another element.

Apparent Reproducibility of the EP

With the above in mind, we turn to a review of these studies insofar as they bear on the reproducibility of the EP. The study by the American Electroplating Society (35) examined twelve wastes (sludges) generally representative from wastewater treatment systems in the electroplating industry. The study as a whole consists of thirteen experiments, some of which are still in progress. Two major deviations from the EP were incorporated in the study. First, lumps of solids in the waste samples were broken up by stirring prior to the initial centrifugation or filtering of the sample. As stated in the report, this stirring could possibly cause a higher level of toxic metals in the final EP extract (35, p.2-2). The second deviation from the EP was involved when, after agitation, the beakers with the solid waste material were removed, covered with a parafin cover, and allowed to stand and settle overnight (35, p. 2-4). Both of these deviations from the EP standard invalidate any good estimate of the general reproducibility of the EP. It was noted in the report that filtering vs. centrifugation in the EP can make the difference between passing or failing the threshold values for toxic metals established by the EPA (35, p.2-5). However, the experiment involved only two metals, lead and chromium, and two levels of pH, pH 5 and pH 7. At the specified pH 5 level in the EP, the threshold value for lead was surpassed when centrifugation was used to separate the solid material from the sample. The threshold value was not reached when filtration was used.

The NUS Corporation (36) subjected samples of four waste materials to the EP and analysis using the AA techniques. Few comments in the report related specifically to the reproducibility of the EP, except that the specified EP was used. The NUS study also compared Toxic Extraction Procedures (TEP) with the EP. The TEP is the precursor to EPA's current EP. One statement from the NUS report (36), however, deserves special comment. The report states that sampling error is a factor in the (inter-laboratory) reproducibility test. Even though the report makes the distinction between "repeatability" (intra-laboratory consistency) and "reproducibility" (inter-laboratory concurrence), the statement is not appropriate if aliquots of the same EP extract are used. Specifically, sampling error relates to the overall representativeness of the waste material to be characterized, not to the precision of the EP or of the analytical techniques.

The Oak Ridge National Laboratory (19) employed the EP and analyzed eighteen different wastes, including arsenic-contaminated ground water. The standard EP was followed, except that extractors made of different materials or combination of materials were used. The report states that "no significant problems were encountered in extracting or analyzing wastes for inorganic species"(19, p.2), but several suggestions were offered with regard to various aspects of the EP. For example, stirring problems, e.g., binding and sampling grinding, were encountered with some of the wate material during extraction.

Also, the report recommended that a nonmetallic extractor should be used to lessen the possibility of contamination occurring during waste extraction. In general, however, this report (19) suggests that the EP is relatively reproducible. One statement (19, p.15) suggests that reported values of chromium, nickel and calcium indicate an EP variability trend that exceeds that expected for analytical determinations. This statement applies only to the situation when extractors made of different materials are used. Out of context, the statement would suggest that the EP is unreproducible in either intra- or inter-laboratory stiuations.

A total of twenty-five wastes from eleven different sites were examined in the study by Environmental Monitoring Systems Laboratory in Las Vegas (18). One specific deviation from the EP was employed in the study. All waste materials were screened by inductively coupled plasma emission spectroscopy (ICM) to select those wastes for EP and analyses by AA methods (18,p.22). Also, different kinds of agitation, the wrist-arm shaker and the extractor device, were used in the study. The report states that preliminary results suggest good agreement (from the analyses) between the two types of agitation. Like the Oak Ridge National Laboratory Study (19), this study (18) also suggests that steel containers not be used in the EP because of its possible contamination in tests for chromium. Also, the report states that the variation in the tests for barium are due to the analytical method (not the EP). Other studies are planned which will address the issue of the reproducibility of the EP more directly, but there is little in

the interim report to suggest that the EP is not generally reproducible.

Finally, the study by the Electric Power Research Institute (37) is the only investigation which clearly separates out the question of reproducibility of the EP and the analytical techniques. Further, the complex design partitions (through analysis of variance (ANOVA) techniques) variation of the EP and analysis techniques which can be attributed to inter- and intra-laboratory results. Four types of utility wastes were subject to the EP and analyzed in the study. The design included all the toxic metals except silver. Also, the basic design of the study was intended to compare flame and furnace AA methods of analysis. Unfortunately, because of incomplete data and values for toxic matal content which were sometimes below detection limits, a variety of adjustments were incorporated into the overall statistical analyses. For example, simulation methods were used to produce enough observations to complete the ANOVA design. Geometric techniques were employed because of the highly skewed observations, i.e., results from the test of toxic metals in the waste materials. In all, the results of the study should be given a very conservative interpretation. As noted previously, no interpretation of the results is offered in the study report. However, examination of the data presented and communication with those persons who conducted the analyses suggest two major findings:

First, as might be expected, intra-laboratory reproducibility (consistency) for both the EP and the analytical techniques tended

to be better than inter-laboratory reproducibility (concurrence). Secondly, the reproducibility of the EP overall (both intra-laboratory and inter-laboratory) appears to be better than the overall reproducibility of the analytical techniques. This latter finding suggests that the overall reproducibility of the analytical techniques may be more of a problem than the EP itself. This is contrary to assumptions which have been made in some studies (36) and further questions the use of the analytical results of EP extracts as an uncontrolled criterion to assess the reproducibility of the EP.

Apparent Reproducibility of the Analytical Technique

Most of the five studies reviewed addressed, to some extent, the general reproducibility of the analytical techniques. The data reported, however, is sometimes too incomplete to make any comparisons among the different studies. Consequently, caution has to be exercised in generalizing about the reproducibility of the analytical techniques. Some discussion about the statistical measures used to indicate reproducibility is in order before proceeding to the separate research studies. The measures mentioned or employed across the studies have included the following:

- standard deviations
- relative standard deviation, i.e., the standard deviation expressed as a percentage of the mean
- the coefficient of variability, i.e., the same as the relative standard deviation
- the range of values, i.e., the difference between the

highest and lowest value

- standard error (unspecified), and
- relative standard error, i.e., the standard error of the mean expressed as a percentage of the mean.

Each of these measures can be used to assess relative reproducibility under certain circumstances. In some cases, however, the measures can be misapplied. For example, the best indicator of reproducibility when replications are made of the same test and the values are averaged is the standard error of the mean or the relative standard error, not the coefficient of variability, i.e., the relative standard deviation. The advantage of the standard error of the mean is that probability statements can be made about hypothetical true values, e.g., the threshold values, or different mean values obtained from other tests of the same waste material. The only study to employ the standard error of the mean (specifically the relative standard error) was the NUS Corporation study (36). The relative standard error (RSE) indicates that one can be 95% confident that the true value, e.g., level of toxic metal, is within ± 1 RSE of the mean value obtained. There is no direct way of comparing the coefficient of variability and the RSE. The advantage of the relative standard deviation or the relative standard error is that variation is expressed as a percentage of the mean, thereby facilitating relative comparisons of the variation around the mean, i.e., reproducibility.

The study by the American Electroplating Society (35) presents data on the intra-laboratory reproducibility (consistency)

than a certain value (ppm).

Sample	Element	Mean	SD	RSE
Fly Ash	Arsenic	.227	.226	±66%
	Chromium	.08	.032	±27
BOF Slag	Lead	.441	.107	±16
Refinery Sludge	Arsenic	.017	.006	±24%

These results indicate moderate intra-laboratory reproducibility (consistency) for four of the elemental analyses conducted on three types of solid waste EP extracts.

The study conducted by Oak Ridge National Laboratory (19) presents some data on the intra-laboratory reproducibility (consistency) of analytical techniques on a variety of EP extracts of waste. However, not enough information is provided to estimate the variability or estimate reproducibility since only mean values or single determination values are presented (19, p. 37).

Finally, the general results regarding the apparent reproducibility of analytical techniques in the Electric Power Research Institute study (3) have been presented previously under the discussion on EP reproducibility. Since the results in the study are presented within an ANOVA design, it is difficult to assess the different aspects of variability except in relation to each other. Also, examination of the 90% Confidence Multipliers (CMs) shows mixed results on inter-lab analysis variability and intra-lab analysis variability according to type of analyiss and type of toxic metal. For example, the CMs for inter-lab analytical variability on page 14 of the report (37) range from 1.01 to 13.02. The CMs for intra-lab variability are generally

less, but range from 1.01 to 1.41. These ranges exclude analyses where "the number of values reported as 'below the detection limit' was not so large as to preclude statistical analyses, but large enough to make the results less reliable" (3, p. 3 of Phase I Report). The effect of the simulated values on the CMs is not known exactly. Consequently, only tentative conclusions, or hypotheses, about reproducibility seem justified from the report.(37)

In conclusion, the above reports, while not complete enough to permit any firm conclusions, do contain data which is suggestive on the issue of reproducibility. Of particular interest is the suggestion in the EPRI data that the EP is at least as reproducible, if not more reproducible, than the analytical techniques. In as much as these analytical techniques have generally been accepted by industry and others as being sufficiently precise for regulatory use, the EP should also prove acceptable.

4. Accuracy of Test Procedure

A number of commenters questioned whether the EP was sufficiently accurate for use in a regulatory regime. By this they apparently meant one of two things: either that the EP inadequately predicts the leaching which might occur under the disposal conditions postulated in the EP's definitional model or that the EP is not sufficiently precise to enable one to be confident in the results obtained from a given testing.

In response to the first criticism, the Agency believes, based on its hypotheses noted above, that the EP (not including the attenuation factor) is an accurate prediction of the levels of leaching which could occur in a relatively aggresive leaching environment. The Agency concedes however, that it may have fallen somewhat short of fully modeling the leaching which could occur in a actively decomposing municipal landfill--in part, bacause its leaching medium fails to take into account the various chemical, biological and physical factors which bear on the aggressiviness of municipal landfill leaching media. The Agency further concedes that it had little empirical data upon which to base its assumptions about the accuracy of leachability on site specific considerations. Obtaining such empirical data may be an ephemeral goal. Nevertheless, the Agency hopes to assemble data on leachate concentrations observed at actual landfill sites in an attempt to gauge the representativeness of the EP.

In response to the second criticism, the Agency believes that the EP is sufficiently precise to enable one to obtain reasonable confidence in the results of the test--especially given the fact that one can always obtain greater confidence in the results by running further replicates of the test. The width of the confidence interval has an inverse relationship to the number of tests run on a given sample. Consequently, if there is a question whether a given test is reflective of the "true" result, it becomes a simple matter to run additional samples until the desired confidence is obtained.

5. Propriety of Requiring Exercise of Scientific Judgement

A number of comments argued that the Extraction Procedure, as published in 43 FR 58956[9], was not well enough defined to permit the unambiguous interpretation of how the procedure should be followed. Furthermore, problems arose in conducting the liquid-solid separation and in agitating the sample during the extraction phase of the procedure.

The Agency agrees with these comments and has taken steps to eliminate the difficulties. Some of the specific changes that have been made relate to:

1. specification of filtration as the final stage in sample preparation prior to measurement,

2. specification that the purpose of centrifugation is to aid in liquid-solid separation, not as the final means of separation,

3. use of a generic specification of the agitation equipment

4. codification of under what conditions the sample contains so little solid that it can be considered to be a liquid for testing purposes.

In addition to changes that have been made in the procedure description* the Agency is making available to the public a methodology manual (27) to present additional descriptive information on the sampling and testing methodologies used in the evaluation of wastes. The purpose of this manual is to give more specific operational information than would be practical to put in the regulation itself.

* Appendix II of the §3001 regulations.

This manual will contain information about testing specific wastes, including clarification of any procedural steps needed to correct interpretational difficulties. The Agency intends to keep the manual current by updating it on a regular basis.

However, the Agency believes that no laboratory procedure for waste testing can ever by written that unambiguously addresses all potential interferences. The testing methods have been written for use by experienced scientific personnel. It is felt that such persons will be able to overcome potential problems and obtain acceptable data, given an adequate understanding of the intent of each phase of the testing procedures.

Specific examples of how this philosophy would work can be gleaned from an examination of some of the comments. One organization subjected oak and maple leaves to the Extraction Procedure and experienced significant difficulty in attempting to separate the extractant liquid from the leaves. The intent of the liquid-solid separation step is to remove all particles of the extracted sample having a particle size greater than 0.45 micrometer from the extract. Thus, an experienced scientist would know to allow the leaf particles to settle, under the influence of either gravity or centrifugal force, decant off and filter the bulk of the liquid, then transfer the remaining mass of leaves to the pressure or vacuum filter for removal of the small amount of free liquid that remains. This

change, though not significant from the standpoint of the final results, would have eliminated the long filtration time experienced by the commenter.

A second example which serves to illustrate this point relates to the large number of comments the Agency received on the agitation apparatus described at 43 FR 58961 . These comments concerned problems with the specific extractor described in the proposed regulations. These problems consisted primarily of jamming when an attempt was made to extract hard, granular wastes, and potential extract contamination caused by using a metallic extractor.

As described in the proposed regulation:

> "A suitable extractor will not only prevent stratification of sample and extraction fluid but also insure that all sample surfaces are continuously brought into contact with well mixed extraction fluid."(9)

The Agency believes that with this description a competent scientist can eliminate any problems, of the above types, encountered with specific wastes or agitators. If the sample is of such a size and consistency that jamming occurs due to the spacing between the extractor blade and the container, then either an agitator with a different spacing should be used or, if this does not eliminate the difficulty, a different type of agitator should be employed. This latter approach was used by several commenters in determining the leachability of

materials such as coal combustion ash. Though the studies conducted at Oak Ridge National Laboratory (7,19) and Las Vegas (18) indicated that contamination of the extract by an extractor fabricated of Type 316 Stainless Steel was not a significant problem, the Agency feels that if this problem actually manifests itself, scientist conducting the tests will know to employ an extractor fabricated of either plastic or glass, since neither material would hinder attainment of the agitation conditions specified in the regulation.

The most significant problem encountered by commenters in applying the Extraction Procedure to a specific waste, occurred when filtering samples of drilling mud. Due to the thixotropic and pore clogging properties of such materials, neither filtration nor centrifugation was able to effect separation of the liquid and solid phases. It is the Agency's position that, in such cases, the whole waste should be treated as a solid and run through the extraction procedure. If, after performing the extraction procedure, no extract is obtainable, the waste should not be considered hazardous.

C. Failure to Distinguish Between Chromium III and Chromium VI

A number of comments argued that, basing an Extraction Procedure Toxicity threshold on total chromium in the extract was improper*. These commenters argued that the two oxidation states of chromium present very different toxicity and environmental problems and therefore the threshold should be based only on the concentration of chromium in the +6 oxidation state.

In support of this position the following was cited.

- Cr(VI) is significantly more toxic than Cr(III).
- Oxides and salts of Cr(VI) are very soluble in water while those of Cr(III) are relatively insoluble.
- Cr(VI) has been shown to be a potent carcinogen in humans while Cr(III) on the other hand has not been shown to be carcinogenic in either humans or animals.
- Monitoring of groundwater below a landfill receiving tannery waste containing chromium in the reduced +3 state has shown only limited migration after a period of 10 years. (45)
- There is no data to indicate that under conditions of land burial Cr(III) can be converted to Cr(VI).

* The major group affected by the application of thresholds, appears to be the leather tanning industry. According to a study conducted for the E.P.A.(46) and comments received in response to the proposed regulations(47), the tanning industry generates and disposes of approximately 200×10^6 Kg of waste per year containing approximately 1000 metric tons of chromium.

In formulating both the National Interim Primary Drinking Water Standards and these regulations, the Agency has chosen not to adopt separate thresholds for the various oxidation states of chromium. The reason for this is the Agency's concern about the possibility of the conversion of chromium from the relatively nontoxic +3 form to the toxic +6 oxidation state after disposal occurs. This concern is based on studies and observations reported by researchers of the California Department of Health (48) and conditions known to occur in municipal waste disposal environments.

A great deal of controversy exists about the environmental and health effects of chromium. The two most important oxidation states of chromium for environmental purposes, are chromium III and chromium VI. There is general agreement as to the hazards posed by the chromium VI state since it exhibits toxic effects to humans and animals by every route of exposure and is reported to be relatively mobile in the environment(48). On the other hand, available evidence indicates a generally low oral toxicity for chromium(III) compounds. The reason for the controversy over the hazard posed by wastes containing Cr(III) revolves around its possible conversion into the more toxic Cr(VI) form under conditions that might reasonably be expected to occur in the environment.

The California researchers(48) found that upon exposure to artificial ultra violet light or sunlight, significant oxidation of Cr(III) to Cr(VI) takes place in water within a pH range

of 7 to 10. Exposing an aqueous suspension containing both soluble Cr(III) and precipitated $Cr(OH)_3$, to ultraviolet light and air for 5 days resulted in oxidation of approximately 20% of the total chromium to the Cr(VI) state. After 7 days the percentage of chromium in the Cr(VI) state approached 50% and after 41 days the percentage approached 90%. Definitive evidence of the photo-oxidation of Cr(III) in actual chromium bearing tannery wastes has not been obtained. According to the California researchers:

> "Analysis of these wastes for Cr(VI) has proven unreliable using any of the published methods. These analytical methods all involve acidification of the Cr(VI) solution prior to final analysis because the tannery wastes all contain relatively high concentrations of dissolved organics, and because Cr(VI) is quickly lost by reduction by the organics. We have found that this redox reaction takes place very rapidly and results in irreproducible results for Cr(VI) concentrations. It is commonly held that chromium tannery wastes do not contain hexavalent chromium and the basis for this belief is negative analytical results based on the EPA or Standard Methods procedures(49). Close examination indicates that these negative chromium(VI) data may well be an artifact of the method and do not reflect the true hexavalent chromium content of the tannery wastes."(48)

Given the fact that the oxidation of Cr(III) to Cr(VI) has been demonstrated to occur under relatively mild conditions, and that this demonstration is consistent with the observation that the predominant form of chromium in the surface layers of the sea is the hexavalent form (48), the possibility that Cr(III) in wastes may undergo oxidation after disposal cannot be ruled out.

In summary, the Agency believes that pending further studies to determine the extent to which this conversion does or does not occur under environmentally significant conditions, the only prudent course of action is to consider all forms of

chromium potentially toxic. The Tanners' Council of America in their comments on the proposed regulations echoed this conclusion. To quote:

> "A study conducted in California found that ultra-violet light and sunlight promoted the oxidation of chromium. It is appropriate, therefore, that the disposal of wastes containing trivalent chromium be regulated so that these wastes are quickly and adequately covered at the disposal site to minimize their exposure to sunlight."(5)

If future research indicates that such a course of action is not warranted, then the Agency will revise the definition of a hazardous waste accordingly.

D. Operational Problems

Introduction

The comments previously discussed, dealt with what could be termed philosophical disagreements with the proposed toxicity characteristic. In addition to these philosophical questions, a number of comments were received concerning the actual operation of the Extraction Procedure. These comments can be grouped into the following areas:

1. Liquid - solid separation procedures
2. Structural integrity procedure/ Grinding of sample before extraction
3. Problems with the extraction equipment/agitation
4. Adjustment of extract pH
5. Sample: extractant ratio
6. Final volume adjustment
7. Analysis of multiphasic extracts
8. Extractant toxicity as it affects testing of the extract.

This section will address those changes made in the proposed procedure as a consequence of these comments, and explain other suggested changes that were not made.

1. Liquid-solid Separation Procedure

As was briefly discussed earlier, significant problems were en countered by a number of commenters in separating the liquid phase of the sample from the solid phase using either the filtration or the centrifugation procedure. In the case of thixotropic materials such as drilling fluid and paint these difficulties were severe.

As discussed above, the Agency believes that if no liquid phase can be generated using the separation procedure, the whole waste should be treated as a solid and subjected to the extraction. If, after the extraction procedure is performed, no liquid is produced, the waste should be considered nonhazardous.

The separation problems encountered with the wastes other than paint and drilling fluid appeared to be readily overcome using standard laboratory techniques although, possibly because of the manner in which the test procedures were written, the availability of these solutions may not have been readily apparent to the laboratory personnel. In the main, these problems consisted of either clogging of the filter membrane pores or lack of a centrifuge which met the specifications described in the proposed regulation.

In order to overcome these problems, the following changes have been made.

a. The centrifugation procedure is now defined in terms of goals and no specific equipment is specified. This change clarifies the concept that centrifugation is actually more a tool for prefiltration sample preparation than a final separation technique itself.

b. The filtration step is no longer defined in terms of specific equipment. The procedures manual(27) will contain all references to specific equipment to make it clear that specific pieces of equipment are not being mandated. The procedures manual(27) will also clarify for the operator what procedural changes one may make without invalidating the test.

These changes in the description of the filtration step should clear up any uncertainty about the use of vacuum filtration. It is the intent of the Agency that if the solid phase does not require high (75 psi) pressure to affect separation, then use of the more readily available vacuum filter is allowable. The use of the pressure filter offers a means of operationally defining, at what point a wet solid can be considered a solid for purposes of extraction. (For example, when to treat a sludge, though it might actually still contain 85% water, as a solid for extraction purposes.)

The following discussion will address specific criticisms and operational problems brought out in the comments. The first of these relates to the potential clogging of the filter pad by wastes having

low liquid to solid ratios. This situation may result in a reduced degree of separation and long filtration times. The Agency believes this potential problem is easily overcome. In such cases, if the solid tends to clog the filter pores, an initial centrifugation to compact the solid is recommended. The liquid thus obtained is then filtered to remove carryover particles, and the solid remaining is filtered under gradually increasing pressure. Specific directions will be given in the methodology guidance manual(27) for those investigators unfamiliar with such techniques.

Section 250.13(d)(2)(1)(A)(1) of the proposal(9) called for filtration to continue until no significant amount of fluid (<0.5 ml) is released during a 30 minute period. Commenters felt that for many wastes this is unnecessary. In addition, one commenter, suggested that filtration should be stopped when gas issues from the filter since allowing gas to bubble out of the filter for up to 30 minutes can cause the volatilization of materials from the filtrate.

The Agency agrees with these recommendations and has made the necessary changes in the regulation. In order to eliminate confusion on the part of the testing community without resorting to overspecification, the regulation has been changed to describe what is intended and to delete specification of the filtration time. Laboratory personnel can use whatever filtration time is required for the specific waste. In addition, the final regulation specifies that filtration should stop when gas issues from the filter. This should eliminate any potential problems with gas discharge.

Section 250.13(d)(2)(i)(A)(1) of the proposal(9) called for inverting the filter unit when changing the filte ds. The Agency has been told that filter holders supplied by one manufacturer cannot be inverted without leaking. Thus, the regulations have been changed to eliminate this specification. If membrane changes are necessary to complete the required separation, instructions from the manufacturer of the specific filter holder being employed should be followed.

Some of the commenters reported that when the pressure filtration technique was applied to different wastes, filter cakes with significantly different amounts of moisture were obtained. They felt this indicated a problem with the technique. The Agency disagrees with this interpretation. The filtration procedure is intended to simulate the separation that may occur in a landfill. If the liquid refuses to separate out during pressure filtration, it will also tend not to drain away from the waste when the waste is placed in a landfill.

Comments were received which said that requiring two consecutive 30 minute centrifugations without an apparent change in degree of separation was excessive. The Agency disagrees with this comment but notes that this concern has been accomodated by adoption of the more flexible centrifugation procedure. Because studies indicated that centrifugation alone resulted in carryover of particles > 0.45 um, centrifugation is now simply used as a means of achieving a preliminary separation in order to

speed up filtration. All centrates are to be filtered to remove fine particles prior to analysis. This change in the centrifugation procedure addresses the concerns of other comments relating to addressed:

a. Problems with centrifugation of wastes containing solids having lower densities than the liquid phase, and

b. The need to define centrifugation conditions in terms of separation force (g forces) instead of rotor speed and diameter.

2. Structural Integrity Procedure/Grinding

In order to accomodate generators whose wastes are not expected to undergo significant structural degradation after disposal because of their monolithic structure or subjection to special "fixing" processes, the Agency developed and incorporated the Structural Intgrity Procedure into the proposed regulations(9). This procedure received criticism from several persons and groups. The specific criticisms were:

a. any alteration of the test specimen is not representative of actual field conditions,

b. the specific field conditions used as a model for the Structural Integrity Procedure are completely contrary to conditions that actually exist in the field,

c. the equipment specified in the proposed regulations(9) is unavailable and, thus, industry has not been able to adequately evaluate the procedure,

d. it is impossible to obtain an undisturbed field specimen of the size and shape required,

e. the foam block employed as a sample holder is subject to contamination, and

f. the Structural Integrity Procedure lacks sufficient scientific validation,

Though some of these comments are valid, the Agency does not believe that the information presented in the comments is

sufficient to warrant either dropping or substantially modifying the test procedure.

The following states the Agency's reasons for retaining the proposed Structural Integrity Procedure and the reasons why changes have not been made.

None of the comments presented any evidence to support the claim that stabilized, or other monolithic wastes, fail to undergo degenerative structural changes after disposal. In fact, studies (51 and 52) indicate that significant deterioration actually occurs in some cases. One such situation was found to occur with fly ash stabilized with a popular commercial fixation process (52). Thus, the Agency believes that in order to carry out its mandate under RCRA to consider potential for harm under improper management conditions, it is reasonable to extract wastes in their degraded form if degradation is actually going to occur in the field.

A second point raised by commenters concerns the field conditions modeled by the Structural Integrity Procedure. While subjecting stabilized waste to compaction stresses is not routine practice, it is by no means unknown. Advertisements have appeared in a number of publications, including the Washington Post, stressing the beneficial uses to which stabilized waste can be put. Among the uses suggested was as a replacement for gravel in construction applications (e.g., forming bicycle paths). Since such uses are possible, and, in

the case of some wastes probable, it appears reasonable to assume the waste may be subjected to the compaction forces imparted by earthmoving equipment such as tractors. Given such an assumption, the Structural Integrity Procedure, which is a modification of an established procedure for simulating the effects compaction machinery has on soils, appears to be based on reasonable assumptions.

The comments made with respect to the unavailability of the equipment were due to a misunderstanding on the part of the commenters. The equipment design belongs to EPA, not to any one company. The design and specifications were published at 43 FR 58691(9) and anyone desiring to obtain the equipment could either fabricate it in their own facilities or obtain it from a competent machine shop. EPA published the name of the particular supplier from which EPA purchased its units solely for the convenience of the public.

The Agency agrees with the concern that obtaining an undisturbed specimen of an already disposed of monolithic waste presents a problem. However, the agency envisions preparing samples of the correct size and geometry by casting the fresh waste in a suitable mold, allowing it to cure for the specified time, and then subjecting it to the procedure. This is analogous to the methodology commonly employed in the construction industry for testing the strength of concrete.

For those situations where a specimen is required of an already inplace waste, geological coring equipment (which is inconvenient and potentially expensive) can be employed.

The Agency recognizes the concern with particles becoming trapped in the cellular polyurethane sample holder causing contamination of subsequent samples. To eliminate this potential problem, the equipment specifications have been broadened to permit the use of non-cellular sample holders which are easily cleaned between tests.

EPA believes that even though the reproducibility of the Structural Integrity Procedure has not been determined, the advantages of including the test in the regulations outweigh the potential disadvantages. Elimination of the test would require everyone testing waste to grind it to pass a 3/8" sieve. Retention of the Sturctural Integrity Procedure imposes no additional burden on the regulated community and, at the same time, allows generators who stabilize their wastes against leaching a means of demonstrating this property.

Grinding

A comment was received concerning the fact that some wastes were difficult to grind. The commenter reported that attempting to grind a waste in a blender resulted in the blender breaking. The Agency realizes that some wastes may be very hard. A blender is not designed to be a grinder. If a hard material is to be ground, then equipment designed for such use should be employed. Such equipment is readily available from companies

servicing metallurgical and plastics testing laboratories.

In addition, if the material to be tested is so strong that grinding actually presents a problem, then it is likely that such a material would not tend to be ground in the environment and should therefore be evaluated using the Structural Integrity Procedure.

3. Agitation

A number of comments were received concerning problems people encountered, or envisioned, while employing the extractor pictured in Figure 1 of the proposed regulation (43 FR 58961)(9). These comments fall into the following groups:

a. The extraction conditions (40rpm) do not prevent stratification.

b. In certain cases the extractor blade will jam, with the result that the motor can burn out.

c. When using very small samples the top blades do not contact the solution.

d. When solids having a very low density are tested, there is insufficient room in the extractor to accommodate all the solution and still agitate the system vigorously.

e. Use of stainless steel as the material of construction may result in contamination of the extract with various metals.

f. The extractor is not large enough to permit the preparation of sufficient amounts of extract to allow one to conduct the test procedures described in the Advance Notice of Proposed Rulemaking (43 FR 59022)(9).

The Agency recognizes the validity of these comments but believes they are not significant enough to have required a change in the proposed regulation. This conclusion was reached because the regulation, as proposed, incorporated sufficient flexibility to eliminate all these problem areas.

Elimination of these potential problems requires the exercise of scientific judgement on the part of the investigator conducting the tests. The proposed regulation did not specify that any one specific extractor is required. The Agency found that this point was misunderstood by many people. To eliminate confusion a notice was placed in the Federal Register on March 12, 1979 at 44 FR 13548[44]. This notice sought to clarify that the Agency's intent in describing the particular extractor was to illustrate one acceptable type of agitator. The Agency did not intend the unit so described to be considered the only one acceptable.

The Agency believes that the specific extractor used in any particular investigation should be determined after considering:

a. the physical characteristics of the waste,

b. the quantity of sample to be extracted,

c. the method of pH adjustment to be employed,

d. the analyses to be performed on the resulting extract, and

e. the number of waste evaluations to be performed concurrently.

Under these conditions, if the analyst is faced with any of the problems previously mentioned, it becomes a simple matter to select an extractor suitable for the waste in question. For example,

if a waste is being examined for leachable metals, it would seem prudent to use an extractor fabricated of a nonmetallic material if aggressive conditions are to be employed during extraction. Similarly, if jamming is found to occur, an extractor with either a different blade clearance or one which does not require stirring of the particles should be selected.

4. Adjustment of Extract pH

Two commenters mentioned problems with the pH adjustment during the course of the extraction. The first commenter concerned the potential danger of adding acid to a waste containing cyanide, sulfide, or other constituent capable of forming toxic gas. The second comment complained about the cost of the equipment needed to automate the procedure.

With respect to the danger of toxic gas formation, the Agency believes it is only common sense to evaluate the waste for the presence of gas generation contaminants prior to conducting the Extraction Procedure. This is especially important since the presence of such constituents can make the waste hazardous under the Reactivity Characteristic even if the waste does not contain other extractable toxicants.

With respect to the cost of automating the pH adjustment step, two points need to be made. The first is that automation of the adjustment step is not required by the regulations. Secondly, if a laboratory elects to employ automatic titration equipment, for purposes of saving labor costs, the cost of such equipment is much less than the commenter quoted. Specifically, the equipment described in the proposal, and employed during much of the developmental research conducted at the Oak Ridge National Laboratory, retails for $325 (Cole Parmer Co., Catalog #5997-20) while a similar competing unit retails for $495 (Fisher Scientific Co., Catalog #13-637-650).

5. Sample to Extractant Ratio

One commenter commented as follows:

"The solid/liquid ratio used in the EP test is based on "as received" (wet) weight. This severely complicates intersample and interlaboratory testing. Also, diluting from a ratio of 1:16 to 1:20 requires careful quantitative transfer procedures. Why not just use 1:20 or 1:10, since solid to liquid ratios tend to be arbitrary as shown in the Wisconsin study."

This comment addresses two concerns-problems related to working with materials whose composition may change if care in their handling is not taken (e.g., the wet samples may dry out with a resulting change in percent solid), and the fact that careful laboratory techniques are required throughout testing. With regard to the first point, the Agency has chosen to use wet weight for purposes of computing the solid/liquid ratio because use of dry weight might not prove representative of the leachability of the waste. For instance, if the solid residue obtained after the initial separation procedure still contained a fairly high percentage of liquid, drying the solid residue would dramatically increase the concentration of toxic contaminants in the solid sample with a possible attendant increase in the quantity of contaminants leached from the waste. At the same time drying the solid residue could severely understate the leachability of the waste, as in the case of electroplating wastes. Data

in the Agency's possession indicates that, for some unknown reason drying electroplating wastes results in lower contaminant concentrations in the leachate (35).

With regard to the second point, the Agency believes that the need for care in performing the analytical transfers does not justify changing the regulations inasmuch as it is in the very nature of analytical chemistry to require such care.

6. Final Volume Adjustment

One commenter suggested that for operational convenience it may be desirable to perform the extract dilution prior to the liquid solid separation step. The following formula for determining the amount of water to add was suggested:

$$V = (20)(w) - (16)(w) - (a)(HOAc)$$

where:

V = ml of water to add

w = weight in gms of solid charged to extractor

a = ml of acetic acid solution added during extraction.

Since this procedural change neither changes the intent nor results of the dilution step, and does save the laboratory investigator time, the Agency has adopted the suggestion and changed the regulations accordingly.

7. Analysis of Multiphasic Extracts

A number of comments were received concerning the analysis of multiphasic liquid extracts. These comments and questions indicated to the Agency that more guidance is needed in this area.

There are basically two methods for handling multiphasic liquid extracts. The phases can be separated, their volumes measured, separately analyzed and then mathematically combined to determine the original concentration for each species in question. Alternatively, the operator can mix the multiphasic mixture, using a high shear mixer (e.g., homogenizer), withdraw an aliquot, then subject the aliquot to a total extraction or digestion depending on the species of interest.

In order to eliminate confusion on the part of the regulated community the Agency has added clarifying wording to the regulation and will give further guidance in the methodology manual(27).

8. Extract Toxicity

A large number of comments expressed concern that the presence of acetic acid, or acetate ion, would interfere with bioassay testing of the extract. This concern is partially valid inasmuch as acetate is known to interfere, in some cases, with the phytotoxicity bioassay procedures currently under development by the Agency (19). However, since the final regulations do not call for any bioassay testing to be performed on the extract, this potential for interference is a moot point. Research at ORNL (7,19) indicates that EP extracts can be evaluated for both mutagenicity and aquatic toxicity without serious interference from the leaching medium. As noted, above, the Agency is continuing work on a leaching medium which will not interfere with bioassay testing.

Some commenters expressed the concern that the acetate would interfere with chemical analysis of the extracts. The Agency knows of no data to indicate that this concern is anything but theoretical and so is not convinced that a change in the methodology is required. If, in the future, there is a demonstration of such interference appropriate changes will be made.

E. Economics of Testing

A number of comments were received on the cost of the test procedures required to be performed by the regulated community. There are two aspects to this concern. The first is the actual cost for performing the specific tests. The second relates to the question of what tests the regulated community will be required to perform on their wastes.

In responding to this comment, it should be noted at the outset that RCRA does not require EPA to take costs into account in formulating its regulations. The Agency believes, however, that the cost of running the EP on one's waste is, by any standard of judgement, reasonable.

The cost of determining whether a waste meets the Extraction Procedure Toxicity Characteristic can be divided into the cost for obtaining the sample and the cost of testing the sample.

Sampling costs are largely dependent on the waste, the generator, and even the plant involved. The Agency believes that it is only right to require one who is disposing of a waste to know what the properties of the waste are. In order to accomplish this one must have a sample of the waste. Thus, collecting a sample of one's waste is not felt to be an unjust burden.

The Agency has found that independent laboratories are quoting prices for testing a specific sample, using the Extraction Procedure and associated analytical procedures, to be in the range of $200-600 for the required tests. These are single sample prices and, for most companies who have several wastes to test, would actually be at the low end of this range (approximately $200).

F. Specific Comments on the Noticed Reports

Since publication of the proposed regulations, the Agency received and made available to the public a number of reports dealing with the development of the Extraction Procedure Toxicity Characteristic. These reports are:

- Compilation and Evaluation of Leaching Test Methods (EPA-600/2-78-095)[15]
- Comparison of Three Waste Leaching Tests (Final and Executive Summary) (EPA-600/2-79-071)[16]
- Toxicity of Leachate, Interim & Final Reports, Oak Ridge National Laboratory[7,19]
- Assessment of RCRA/EP Test Results on FBC Residues: Part II[53]
- Electroplating Wastewater Sludge Characterization, EPA-AES Cooperative Agreement, September 12, 1979[35]
- Evaluation of Solid Waste Extraction Procedures and Various Hazard Identification Tests, NUS Project Number 6745[36]
- Proposed RCRA Extraction Procedure: Reproducibility and Sensitivity, EPRI, November 1, 1979.[37]
- Evaluation of Procedures for Identification of Hazardous Waste, Interim Report, EMSL-LV [18]
- Background Study on Development of Standard Leaching Test (EPA-600/2-79-107)[14]

Approximately 30 comments were received in response to the Agency's notice of these reports. In the main the comments did not address themselves to the specific scientific results reported in these studies. Rather they addressed their interpretation of the meaning of the work in relation to the proposed toxicity definition as enunciated in the EP Toxicity characteristic and the criteria for delisting.[9]

While the comments dealt with a number of issues, most of these have been discussed previously in this background document. This section will address the remaining issues as well as clarify several points made by commenters who had apparently not availed themselves of the explanatory material made available in the draft Toxicity Background Document[6] and thus were not aware of the intent and rationale behind the work done during these studies.

Comment: No factual basis for defining hazard has been developed in these studies and no recognized standard of judgment has been applied to this work.

Response: The basis for the Extraction Procedure developed as a result of these studies has been described previously in this document. The basis for the bioassay tests has been discussed in the aforementioned draft Background Document.[6] The reason different dilutions of the EP extract were examined for toxic effects in the various bioassays relates to the fact that the model of environmental exposure used in developing

the EP Toxicity characteristic postulates different degrees of dilution for different targets of exposure (e.g., fish, plants). Chronicly toxic effects toward the aquatic and terrestrial plant environments were thus studied at the expected levels of exposure. The organisms employed in these studies were believed to be sensitive enough for such an approach to be used.

Comment: "CMA recognizes that an uncomplicated short-term test is necessary for initial screening of the large body of wastes to define potential hazard. The single elution, solid/liquid ratio, and the time per elution of the proposed EPA are a practical compromise to more complex procedures such as the SLT reviewed in the subject document. The setting of a threshold concentration as the basis for defining hazard makes proper use of the most important data such tests develop".

Response: The Agency appreciates the fact that these commenters took the time to let EPA know they concur with our conclusion.

Comment: Work done by ASTM under Phase II of a study supported by the U.S. Department of Energy indicated that the EP is not reproducible.

Response: The Agency is aware of this study but has been unable to obtain a copy of the results from the sponsoring ASTM subcommittee. Thus, the results of this work have not

been included in the data base used to develop the EP characteristic.

Comment: The quality of the work performed at ORNL is suspect since less than adequate quality assurance procedures were employed.

Response: The Agency believes the work performed at ORNL[7,9] to be scientifically valid pending any specific evidence to the contrary.

Comment: The EP is not reproducible.

Response: While this point was raised in a number of comments, the comments by two groups, the American Petroleum Institute (API) and the Utility Solid Waste Activities Group (USWAG) were the most specific and detailed and thus have been specifically addressed.

In general, the Agency agrees with many of the criticisms noted in the API and USWAG comments relative to the incompleteness of the data base, and its ability to precisely define the reproducibility of the EP and analytical procedures. However, as with the studies themselves, the commenters often do not clearly distinguish in their comments between reproducibility as it relates to the EP or as it relates to the analytic techniques. Also, there appears to be some expectation that the EP and analytic techniques should have similar reproducibility

indicators for each of the eight elements and for each of many different waste types. This may represent a fundamental misconception about the reproducibility of both the EP and the analytic techniques. This expectation is somewhat similar to expecting that a test battery that measures vastly different types of abilities should have an overall reliability estimate that applies equally to all age groups. Further, as in the studies themselves, the comments do not indicate what would be an acceptable level of reproducibility. Failure to provide some guidelines of what general levels of reproducibility would be acceptable for the EP and the analysis techniques tends to compromise the criticisms offered. The critical issue is whether the proposed EPA guidelines and regulations regarding the EP and analysis techniques have adequate reproducibility to serve as a screening mechanism for identifying potentially hazardous wastes. It should be borne in mind that since the Agency has raised the definitional threshold to 100 times the applicable NIPDWS threshold, many of the criticisms made by the commenters do not apply. This is due to the fact that at higher thresholds the toxicants are analytically easier to measure and the percent error would be expected to decrease significantly.

API Comments

The API comments concern a review and discussion of the results of the four studies [18,35,36,37] conducted on the reproducibility of the EP and AA analysis techniques. The

four separate studies were conducted by Electric Power Research Institute (EPRI),[37] NUS Corporation [36], the American Electroplater's Society (AES)[35] and the EPA Environmental Monitoring Systems Laboratory,[18] respectively.

Comments on the NUS study [36] tend to misinterpret the relative standard error (RSE) used by the NUS investigators as an index of reproducibility. For example the comments include the statement that the standard error which defines the distribution of the means is related to the standard deviation (36, p.4). This is true, but the standard error (of the mean) is also a function of the number of analytic replications, an important component in determining the size of the standard error (of the mean). In this regard, the comments state that "API would hesitate to accept any procedure with such a high analytical error" (± 30% RSE) (36, p.4). With a ± 1 RSE representing the 95% confidence interval about the mean value of lead in BOF slag, one wonders what RSE would be acceptable to API.

The Agency generally agrees that the NUS report is not a thorough study and is incomprehensible (36, p.5) but cannot agree that levels of toxic metals below detection limits should be reported as 0.000 ppm and included in the analysis (36, p. 5). EPA believes that values at or near the limit of detection and which are orders of magnitude below the threshold levels should not be included in reproducibility estimates, only those levels near the threshold values or

above should be included.

Comments regarding the EP and Toxic Extraction Procedure (TEP) comparisons in the API Comments are irrelevent since the EPA regulations specify only the use of the EP.

API comments on the EPRI report[37] seem valid generally, except that the comments regarding the Confidence Multipliers (CMs) in the EPRI report tend to ignore the study limitations noted by the authors of the EPRI report. Many of the extreme confidence intervals include analyses which the authors of the EPRI study note should be interpreted with caution (because of variability due to unallocated error or because the number of values below detection units are large enough to make the results less reliable) (p. 3 of Phase I report).[37] Also, reporting extreme 90% confidence limits as percentage of the mean is a somewhat misleading way to present reproducibility data. The percentages reflect both measurement error <u>and</u> 90% of the area included under a normal distribution.

API comments on the study by the EPA Environmental Monitoring Systems Laboratory (EMSL)[18] in Las Vegas tend to be confusing. For example, ICP was used as a screening device by EMSL to determine what wastes would be subjected to the EP and the AA analyses. The API comments, however, discuss the ICP results as though they were indicators of the EP and analytical reproducibilities. Specifically, the API comments state that the ICP analysis results indicate there is something amiss with the EP or analytical procedure. The ICP has

nothing to do with EP reproducibility. Also, the EMSL is criticized by API for being incomplete even though the report[18] is clearly indicated as an interim report and includes statements about further analyses that are planned.

API comments on the AES study[35] intersperse comments on the design of AES experiments with issues relating to the reproducibility of the EP and analytic techniques. For example, in the AES experiment with different levels of pH used for the EPA, the unreproducibility of the EP at the standard pH 5 levels is not established simply because different analytical results were obtained at other pH levels. Even so, the analytic results at pH 5 seemed somewhat more uniform than the analytic results at the other pH levels. As indicated earlier, the API comment regarding the overall reliability of the EP may reflect a misconception that the EP should be equally reproducible for all types of solid wastes.

USWAG Comments

The comments submitted by the Utility Solid Waste Activities Group (USWAG) tend to be more focussed through the API comments upon the specific research results of three studies regarding the reproducibility of the EP and AA analytic methods. In general, the review by USWAG consultants, Envirosphere, submitted along with the comments is a fairly thorough evaluation of the methodological and scientific merits of each of three studies, the EPRI study,[37] the EPA EMSL study,[18] and the NUS Corporation study.[36] The USWAG

comments regarding the variability of analytic results according to the types of wastes and toxic metals examined tends to be supported across the different studies. However, as indicated earlier, reproducibility estimates need to be established for each type of waste and for each elemental analysis.

The USWAG comment regarding the appropriateness of the *use of* <u>*any*</u> *standardized leaching test to "perform more than* an initial screening function" is somewhat confusing. The EP and analytic techniques coupled with the threshold levels serve as a <u>screening</u> <u>mechanism</u> for determining wastes requiring controlled management. The accuracy of the EP and analytic techniques to model actual leaching at specific disposal sites will not be established until studies comparing the model results with actual disposal site leaching are conducted. As was discussed previously, the EP is not meant to model any specific disposal site but is instead a generalized model.

As with the API comments, the measures of the relative standard error used in the NUS report[36] tends to be interpreted as a relative standard deviation (RSD) or coefficients of variability in the USWAG comments. Also, the USWAG comments on the EPRI report[37] include most of the Confidence Multiplier (CMs) for each element included in the EPRI report. If, for example, one only includes those data which are largely complete for the ANOVA design, a somewhat different picture emerges of the reproducibility of intra-

laboratory analyses (consistency) and inter-laboratory analyses (concurrence). The following distributions of CMs are found with a more conservative extraction of the EPRI data (37, p. 14) (indicators of inter- and intra-laboratory reproducibility on the combined AA analysis results).

	Inter-Laboratory Analysis CMs		Intra-Laboratory Analysis CMs	
Intervals	N	%	N	%
1.01-1.25	13	52	20	80
1.26-1.50	0	0	4	16
1.51-1.75	1	4	1	4
1.76-2.00	2	8	0	0
2.01-2.25	1	4	0	0
2.26-2.50	0	0	0	0
2.51 +	8	32	0	0
Totals	25	100%	25	100%

These results suggest that the reproducibilities of intra-laboratory analysis techniques (consistency) are appreciably better than inter-laboratory analysis reproducibilities (concurrence). A different (and less positive) picture emerges when all the data results are considered as in the API comments and the USWAG comments. Also, averaging all the CMs presented in the EPRI study(37) tends to present an inflated picture of the CMs, since the mean is affected

by extreme values and the extreme values are very large CMs. The USWAG comments regarding the NUS report,[36] however, seem justified, except that RSEs are reported as relative standard deviations (same as coefficients of variation).

The report attached to the USWAG comments, completed by the Environsphere Company, is a thorough and insightful review of the three reproducibility studies. However, the Agency questions the inclusion of sampling techniques as part of determining reproducibilities in the "Toxic Waste Test." It is generally understood that the EPA guidelines regarding sampling techniques for solid waste need further refinement. At the present time, the precision and reproducibility of the EP and AA techniques is the central issue. Also, presentation of the "corrected mean concentrations" of elements from the EPRI report (37, pp. 17-19) does not adequately reflect reproducibilities of the analytic procedures, since these values incorporate variances attributable to both the EP and to the analytic technique.

The consultant's report addresses the issues of the incorrect statistical summaries presented in Table 8 of the EMSL[18] report, yet fails to point out that their corrected values indicate an increased reproducibility estimate for the pH levels and percent solid determinations. Also, the Agency cannot understand why, in both the EMSL[18] study and the consultants review, ANOVA techniques were used without multiple comparisons tests. A simple t-test between the highest and

lowest mean values for chromium in Pond P, 2A, and lead in Pond O, 2B, did not indicate significant differences within three replicate analyses of the same samples. The consultants are not particularly clear about how they conducted their own ANOVAs analyses.

Comment: Specification of construction materials for extractor must be flexible in order to accomodate different waste materials.

Response: Neither the proposed nor final regulations specify materials of construction for the extraction equipment. The Agency agrees that those evaluating waste materials should use materials of construction appropriate to the properties of the waste and to the analyses to be conducted.

Comment: None of the reports evaluated analytical procedures for the pesticides.

Response: Due to the unavailability to the Agency of wastes containing significant concentrations of pesticides, these were not included in the test program. However, no comments were received indicating problems in analyzing EP extracts for pesticides.

Comment: Neither vacuum filtration nor mechanical agitation are appropriate for determining if wastes contain volatile materials.

Response: The Agency agrees and is not using the EP to determine if a waste poses a potential hazard due to its content of volatile compounds.

Comment: Concentrating extracts prior to analysis is inappropriate since it does not simulate what happens in the real world.

Response: The commenter appears to misunderstand the intent of the concentration step. The purpose of concentrating the extract prior to analysis is to improve the accuracy of the analytical determination. Thresholds for toxicity are expressed on the basis of concentration in the original extract. Concentrating the extract prior to analysis does not change the measure of toxicity.

Comment: The fact that a sample of sewage sludge failed the proposed criteria for cadmium and mercury indicates the excessive severity of the EP.

Response: The Agency disagrees with this comment. Many municipal sewage sludges contain concentrations of cadmium and other metals sufficient to pose a health hazard if improperly used for soil amendment or fertilization use. Thus these sludges would be hazardous wastes under RCRA. However, using the thresholds promulgated today (i.e., 100X NIPDWS), none of the municipal wastes tested would have met the definition of hazardous waste.

Comment: Use of the resin technique for concentrating organic materials present in the extract as part of the analytical procedures is not suitable for all types of organic compounds.

Response: The Agency agrees with this comment. However, this technique is currently under evaluation and has not been included in the regulations promulgated today.

Comment: The meaning of the results using the arsenic contaminated groundwater is in question given the unknown handling and storage of the sample.

Response: The groundwater sample was not employed to determine if any specific waste was a hazardous waste, but rather served as an investigatory tool. Thus, irrespective of its history, since its composition prior to biological use was determined, the results obtained are valid.

A number of comments were received relative to biological test procedures which had been proposed as part of the de-listing procedures under Part 250.15. Since these test procedures have not been included in the regulation promulgated today, a detailed discussion of these comments will not be included in this discussion. In general, the Agency agrees with the commenters who indicated that the EP extractant liquid seriously interfered with the phytotoxicity test procedure. However, the Agency believes that this problem

with the EP extractant fluid does not apply to either the mutagenicity or Daphnia magna chronic toxicity assays. As has been discussed previously in this Background Document, the Agency does not believe, however, that these assays are ready for general use by the regulated community.

VI. PROMULGATED REGULATION

§261.24 Characteristic of EP Toxicity

(a) A solid waste exhibits the characteristic of EP toxicity if, using the test methods described in Appendix II or equivalent methods approved by the Administrator under the procedures set forth in §§260.20 and 260.21, the extract from a representative sample of the waste contains any of the contaminants listed in Table I at a concentration equal to or greater than the respective value given in that Table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of this section.

(b) A solid waste that exhibits the characteristic of EP toxicity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number specified in Table I which corresponds to the toxic contaminant causing it to be hazardous.

Table I

Maximum Concentration of Contaminants
for Characteristic of EP Toxicity

EPA Hazardous Waste Number	Contaminant	Maximum Concentration (milligrams per lite)
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0
D012	Endrin (1,2,3,4,10,10-hexachloro-1 7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1 4-endo, endo-5,8-dimethano naphthalene	0.02
D013	Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer	0.4
D014	Methoxychlor (1,1,1-Trichloro-2,2-bis [p-methoxyphenyl]ethane)	10.0
D015	Toxaphene ($C_{10}H_{10}Cl_8$, Technical chlorinated camphene, 67-69 percent chlorine)	0.5
D016	2,4-D, (2,4-Dichlorophenoxyacetic acid)	10.0
D017	2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid)	1.0

APPENDIX II

EP Toxicity Test Procedure

A. Extraction Procedure (EP)

1. A representative sample of the waste to be tested (minimum size 100 grams) should be obtained using the methods specified in Appendix I or any other method capable of yielding a representative sample within the meaning of Part 260. [For detailed guidance on conducting the various aspects of the EP see "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods," SW-846, U.S. Environmental Protection Agency Office of Solid Waste, Washington, D.C. 20460.*]

2. The sample should be separated into its component liquid and solid phases using the method described in "Separation Procedure" below. If the solid residue** obtained using this method totals less than 0.5% of the original weight of the waste, the residue can be discarded and the operator should treat the liquid phase as the extract and proceed immediately to Step 8.

3. The solid material obtained from the Separation Procedure should be evaluated for its particle size. If the solid material has a surface area per gram of material

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* Copies may be obtained from Solid Waste Information, U.S. Environmental Protection Agency, 26 W. St. Clair Street, Cincinnati, Ohio 45268

**The percent solids is determined by drying the filter pad at 80°C until it reaches constant weight and then calculating the percent solids using the following equation:

$$\frac{(\text{weight of pad + solid}) - (\text{tare weight of pad})}{\text{initial weight of sample}} \times 100 = \%\ \text{solids}$$

equal to, or greater than, 3.1 cm^2 or passes through a 9.5 mm (0.375 inch) standard sieve, the operator should proceed to Step 4. If the surface area is smaller or the particle size larger than specified above, the solid material should be prepared for extraction by crushing, cutting or grinding the material so that it passes through a 9.5 mm (0.375 inch) sieve or, if the material is in a single piece, by subjecting the material to the "Structural Integrity Procedure" described below.

4. The solid material obtained in Step 3 should be weighed and placed in an extractor with 16 times its weight of deionized water. Do not allow the material to dry prior to weighing. For purposes of this test, an acceptable extractor is one which will impart sufficient agitation to the mixture to not only prevent stratification of the sample and extraction fluid but also insure that all sample surfaces are continuously brought into contact with well mixed extraction fluid.

5. After the solid material and deionized water are placed in the extractor, the operator should begin agitation and measure the pH of the solution in the extractor. If the pH is greater than 5.0, the pH of the solution should be decreased to 5.0 $\pm$ 0.2 by adding 0.5 N acetic acid. If the pH is equal to or less than 5.0, no acetic acid should be added. The pH of the solution should be monitored, as described below, during the course of the extraction and if

the pH rises above 5.2, 0.5N acetic acid should be added to bring the pH down to 5.0 ± 0.2. However, in no event shall the aggregate amount of acid added to the solution exceed 4 ml of acid per gram of solid. The mixture should be agitated for 24 hours and maintained at 20° - 40°C (68°-104°F) during this time. It is recommended that the operator monitor and adjust the pH during the course of the extraction with a device such as the Type 45-A pH Controller manufactured by Chemtrix, Inc., Hillsboro, Oregon 97123 or its equivalent, in conjunction with a metering pump and reservoir of 0.5N acetic acid. If such a system is not available, the following manual procedure shall be employed:

(a) A pH meter should be calibrated in accordance with the manufacturer's specifications.

(b) The pH of the solution should be checked and, if necessary, 0.5N acetic acid should be manually added to the extractor until the pH reaches 5.0 ± 0.2. The pH of the solution should be adjusted at 15, 30 and 60 minute intervals, moving to the next longer interval if the pH does not have to be adjusted more than 0.5N pH units.

(c) The adjustment procedure should be continued for at least 6 hours.

(d) If at the end of the 24-hour extraction period, the pH of the solution is not below 5.2 and the maximum amount of acid (4 ml per gram of solids) has not been added, the pH should be adjusted to 5.0 ± 0.2 and the extraction continued for an additional four hours, during which the pH should be adjusted at one hour intervals.

6. At the end of the 24 hour extraction period, deionized water should be added to the extractor in an amount determined

by the following equation:

$$V = (20)(W) - 16(W) - A$$

V= ml deionized water to be added

W= weight in grams of solid charged to extractor

A= ml of 0.5N acetic acid added during extraction

7. The material in the extractor should be separated into it component liquid and solid phases as described under "Separation Procedure."

8. The liquids resulting from Steps 2 and 7 should be combined. This combined liquid (or the waste itself if it has less than 1/2 percent solids, as noted in step 2) is the extract and should be analyzed for the presence of any of the contaminants specified in Table I of §261.24 using the Analytical Procedures designated below.

Separation Procedure

Equipment: A filter holder, designed for filtration media having a nominal pore size of 0.45 micrometers and capable of applying a 5.3 kg/cm^2 (75 psi) hydrostatic pressure to the solution being filtered shall be used. For mixtures containing nonabsorptive solids, where separation can be affected without imposing a 5.3 kg/cm^2 pressure differential, vacuum filters employing a 0.45 micrometrers filter media can be used. (For further guidance on filtration equipment or procedures see "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.")

Procedure:*

(i) Following manufacturer's directions, the filter unit should be assembled with a filter bed consisting of a 0.45 micrometer filter membrane. For difficult or slow to filter mixtures a prefilter bed consisting of the following prefilters in increasing pore size (0.65 micrometer membrane, fine glass fiber prefilter, and coarse glass fiber prefilter) can be used.

(ii) The waste should be poured into the filtration unit.

(iii) The reservoir should be slowly pressurized until liquid begins to flow from the filtrate outlet at which point the pressure in the filter should be immediately lowered to 10-15 psig. Filtration should be continued until liquid flow ceases.

(iv) The pressure should be increased stepwise in 10 psi increments to 75 psig and filtration continued until flow ceases or the pressurizing gas begins to exit from the filtrate outlet.

*This procedure is intended to result in separation of the "free" liquid portion of the waste from any solid matter having a particle size >0.45um. If the sample will not filter, various other separation techniques can be used to aid in the filtration. As described above, pressure filtration is employed to speed up the filtration process. This does not alter the nature of the separation. If liquid does not separate during filtration, the waste can be centrifuged. If separation occurs during centrifugation, the liquid portion (centrifugate) is filtered through the 0.45um filter prior to becoming mixed with the liquid portion of the waste obtained from the initial filtration. Any material that will not pass through the filter after centrifugation is considered a solid and is extracted.

(v) The filter unit should be depressurized, the solid material removed and weighed and then transferred to the extraction apparatus, or, in the case of final filtration prior to analysis, discarded. Do not allow the material retained on the filter pad to dry prior to weighing.

(vi) The liquid phase should be stored at 4°C for subsequent use in Step 8.

B. Structural Intergrity Procedure

Equipment: A Structural Integrity Tester having a 3.18 cm (1.25 in.) diameter hammer weighing 0.33 kg (0.73 lbs.) and having a free fall of 15.24 cm (6 in.) shall be used. This device is available from Associated Design and Manufacturing Company, Alexandria, VA., 22314, as Part No. 125, or it may be fabricated to meet the specifications shown in Figure 1.

Procedure:

1. The sample holder should be filled with the material to be tested. If the sample of waste is a large monolithic block, a portion should be cut from the block having the dimensions of a 3.3 cm (1.3 in.) diameter x 7.1 cm (2.8 in.) cylinder. For a fixated waste, samples may be cast in the form of a 3.3 cm (1.3 in.) diameter x 7.1 cm (2.8 in.) cylinder for purposes of conducting this test. In such cases, the waste may be allowed to cure for 30 days prior to further testing.

2. The sample holder should be placed into the Structural Integrity Tester, then the hammer should be raised

to its maximum height and dropped. This should be repeated fifteen times.

3. The material should be removed from the sample holder, weighed, and transferred to the extraction apparatus for extraction.

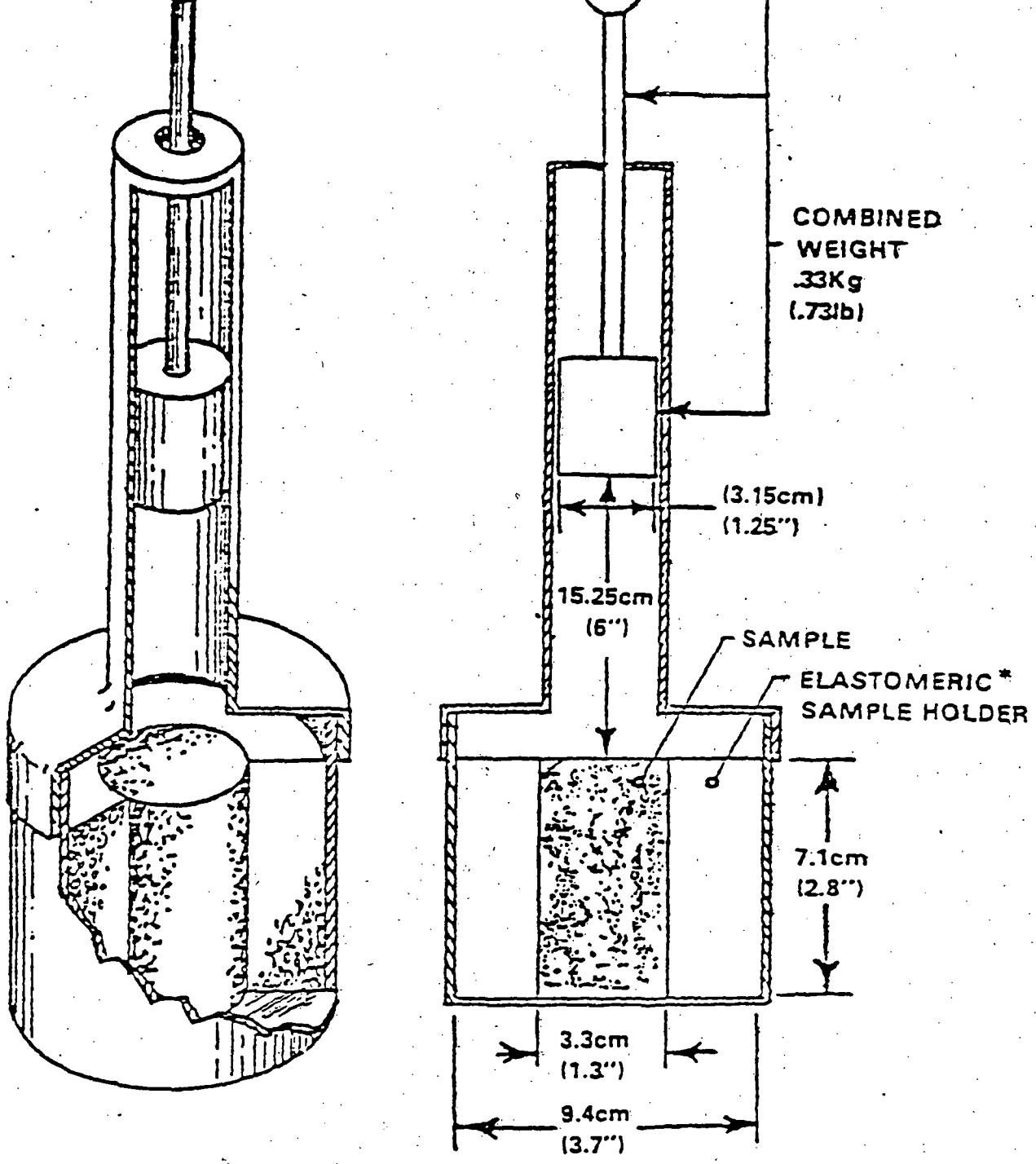
Analytical Procedures for Analyzing Extract Contaminants

The test methods for analyzing the extract are as follows:

(1) For arsenic, barium, cadmium, chromium, lead, mercury, selenium or silver: "Methods for Analysis of Water and Wastes," Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268 (EPA-600/4-79-020, March 1979).

(2) For Endrin; Lindane; Methoxychlor; Toxaphene; 2,4-D; 2,4,5-TP Silver: in "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," September 1978, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 42568.
as standardized in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods."

For all analyses, the method of standard addition shall be used for the quantification of species concentration. This method is described in "Test Methods for the Evaluation of Solid Waste." (It is also described in "Methods for Analysis of Water and Wastes.")



*ELASTOMERIC SAMPLE HOLDER FABRICATED OF MATERIAL FIRM ENOUGH TO SUPPORT THE SAMPLE

Figure 1

COMPACTION TESTER

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U.S. EPA REGION V

IN RE: Gary Development Company
Docket No. RCRA-V-W-86-R-45

COMPLAINANT'S PRETRIAL EXHANGE

FOLDER TWO Exhibit 19

JUDGE GREENE'S CASE FILE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE

PLACE IN 1941.28
PHASE IB

DATE: JUL 15 1980

SUBJECT: RCRA Phase IB Background Documents

FROM: John P. Lehman, Director AW Lindsey for JPL
Hazardous and Industrial Waste Division (WH-565)

TO: See Below

"Complainant's Exhibit No. 19"

The RCRA Phase IB regulations, which add 18 additional waste streams to those promulgated in the Part 261 regulations of May 19, 1980, will be promulgated as interim final regulations via publication as Part II of the Federal Register of July 16, 1980. A background document, supporting the listing of these wastes, is attached. This document also provides the support data for an additional seven wastes, which are proposed in the same issue of the Federal Register.

An additional health and environmental effects document (for aniline) is also attached for inclusion in Appendix A which supports the basic "listing" background documents. A revised Table of Contents, reflecting this addition, is provided for Appendix A; please use this to replace the original Table of Contents.

Attachments

Addressees:
Regional Office Librarian I-X
Regional Office Solid Waste Representative I-X
Public Information Reading Unit, Hq. EPA
Section 3001 Docket, OSW

EPA Form 1320-6 (Rev. 3-76)

1941.28 Phase IB

1941.28
PHASE IB

BACKGROUND DOCUMENT

RESOURCE CONSERVATION AND RECOVERY ACT

SUBTITLE C - IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

§§261.31 and 261.32 - Listing of Hazardous Wastes (Phase IB)

July 7, 1980

U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF SOLID WASTE

Hazardous Waste Listing Background Document

INTRODUCTION

Subtitle C of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 creates a comprehensive "cradle-to-grave" management control system for the disposal of hazardous wastes designed to protect the public health and the environment from the improper disposal of such waste. Section 3001 of that Subtitle requires EPA to identify the characteristics of and list hazardous wastes. Wastes identified or listed as hazardous will be included in the management control system created by Sections 3002-3006 and 3010. Wastes not identified or listed will be subject to the requirements for non-hazardous waste imposed by the States under Subtitle D.

Hazardous Waste List

The purpose of the hazardous waste list as required by Section 3001 of RCRA is to identify those wastes which may present a potential hazard to human health or the environment. The waste so identified is considered hazardous (unless it has been excluded from the list under §§260.20 and 260.22) and subject to the Subtitle C regulations. A solid waste, or class of solid wastes is listed if the waste:

(1) exhibits any of the characteristics identified in Subpart C of the final regulations; or

(2) meets the definition of §261.11(a)(1) of the regulations (i.e., may cause or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness) and thus, presents an acute hazard to humans; or

(3) contains any of the toxic constituents listed in Appendix VIII of Part 261 unless, after considering any of a number of factors, the Administrator concludes that the waste will not meet the criterion of §261.11(a)(2) (i.e., may pose a substantial present or potential hazard to human health or the environment when it is improperly treated, stored, transported, disposed of or otherwise managed).

The Agency considered several approaches for formulating the list. The approaches can be broken down into three main types:

- <u>Hazardous Waste from Non-Specific Sources</u> - these are wastes which are generated from a number of different sources (i.e., electroplating, etc.)
- <u>Hazardous Waste from Specific Sources</u> - these are wastes which would be generated from a very specific source (i.e., distillation bottoms from aniline production, etc.)

- Commercial Chemical Products - these are a list of commercial chemicals or manufacturing chemical intermediates which if discarded either as the commercial chemical or manufacturing chemical intermediate itself; off-specification commercial chemicals or manufacturing chemical intermediates; any container or inner liner removed from a container that has been used to hold these commercial chemical products or manufacturing chemical intermediate unless decontaminated; or any residue or contaminated soil, water or other debris resulting from the clean-up of a spill into or on any land or water, of these commercial chemical products or manufacturing chemical intermediates are hazardous wastes.

(This listing background document will cover the first two categories; the third category of hazard waste is discussed in the background document entitled, "Hazardous Waste from Discarding of Commercial Chemical Products and the Containers and Spill Residues Thereof." This background document was made available to the public when Phase IA of Part 261 was promulgated (May 19, 1980).

HAZARDOUS WASTE FROM NON-SPECIFIC AND SPECIFIC SOURCES

Testing of pure substances is the traditional approach

used by regulatory agencies to control toxic/hazardous chemicals*. The purpose of RCRA, however, is to control waste materials; these are not normally pure substances (except as in the case noted above).

In order for a regulation to be effective, it should be structured so that it reflects the organization of the regulated community. Since waste process streams are often the units of the solid waste regulated by the Act, these same waste process streams can be used to provide a ready means of identification; such that, for our purposes, it is more useful (for identification purposes) to list "still bottoms from the XYZ process - ignitable". Likewise, there are certain waste classes, such as halogenated solvents which, if classified as wastes, would be unambiguously identified by such a designation.

In this document, the Agency is providing the technical support for the eighteen waste streams promulgated (interim final) under Phase IB of the hazardous waste regulations. (The technical support for the 85 waste streams promulgated interim final (45 FR 33123 - 33124) and 11 waste streams (45 FF 33137) proposed on May 19, 1980, under Phase IA has been available

*Pure substance listings work well for many agencies, since their responsibilities lie with some aspect of the pure substance. The Department of Transportation, for example, uses this approach. Benzene is listed by DOT as a flammable liquid. A transporter knows, after consulting the DOT listing, that benzene must be handled according to the DOT flammable liquid regulations.

for review and comment since May 19, 1980.) This document also includes the technical support for the seven new wastes proposed today. This listing (both interim final and proposed) includes two waste streams from non-specific sources and 23 wastes from specific sources. The background data used to support these listings comes primarily from two sources. The majority of this data or information comes from studies undertaken by the Agency or data available to the Agency (i.e., industry assessment studies conducted by the Office of Solid Waste, effluent guidelines studies conducted by the Office of Water Planning and Standards, health effects and fate and transport data compiled by the Office of Research and Development and Office of Water Planning and Standards, damage assessments and incidents compiled by the Office of Solid Waste, etc.). The second source of data came from information collected from State Agencies (i.e., manifest data, etc.).

In addition, this document discusses the comments received on the proposed listings (43 FR 58957-58959 and 44 FR 49402-49404) which are promulgated interim final today, and the changes subsequently made.

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Generic

LISTING BACKGROUND DOCUMENT

PAINT APPLICATION PROCESSES USED IN THE MECHANICAL AND ELECTRICAL PRODUCTS INDUSTRY

- Paint Residues/Sludges* Generated from Industrial Painting in the Mechanical and Electrical Products Industry (T)**
- Wastewater Treatment Sludges from Industrial Painting in the Mechanical and Electrical Products Industry (T)

I. SUMMARY OF BASIS FOR LISTING

The waste streams listed above contain excess paint solids generated in industrial painting operations in the mechanical and electrical products industry. The waste streams contain elevated concentrations of toxic heavy metals and toxic organics.

Under Subtitle C of RCRA, the Administrator has determined that the above waste streams pose a threat to human health and the environment when improperly transported, treated, stored, disposed of or otherwise managed, and has designated these wastes as hazardous. This determination is based on the following considerations:

1. The paints used by the mechanical and electrical products industry contain numerous toxic constituents. These same constituents are also present in the excess paint wastes discharged in the subject waste streams. The specific toxic constituents of concern are: cadmium, chromium, lead, cyanides, toluene, and tetrachloroethylene. Chromium and tetrachloroethylene are believed to posses substantial evidence of carcinogenicity by the Agency's Carcinogen Assessment Group.

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* The term 'sludge' in this context refers to oversprayed paint solids that are disposed of in a wet form.

**These wastes may often be ignitable, but at this time EPA does not have sufficient data to indicate that this is typically or frequently the case. Generator's are responsible for determining whether the waste meets the ignitability characteristic.

2. The toxic constituents of concern are all capable of migration, mobility, and persistence. Improper management of these wastes may result in the release of toxic constituents in these wastes to groundwater and to surface waters, resulting in substantial potential for hazard.

II. INDUSTRY PROFILE AND MANUFACTURING PROCESS

There are more than 88,700 individual manufacturing facilities associated with the Mechanical and Electrical Products Industries (M&EP).[1] These facilities are distributed throughout the 50 states with concentrations in the heavily industrialized areas. Painting is a common operation throughout the M&EP and is present at practically all facilities (1). The paint consumption for a portion of the M&EP industry is given below and is expected to increase at an annual rate of 7.5 percent (1).

Industry	Million Gal/Yr
Manufacture of Transportation Equipment	100
Manufacture of Metal Furniture	25
Manufacture of Prefinished Metal Stock	25
Manufacture of Machinery & Equipment (including electrical)	35
Manufacture of Appliances	20
Metal Decorating	50
Total	255

Paint Application Processes

Paints are uniform dispersions of inorganic and organic substances, which, after application to a surface, convert to a solid film. They may be used for protection, decoration or identification. All paints contain binders and most contain solvents, pigments and additives. Paint may be applied in several physical states: as a liquid (waterborne or organic solventborne); as a high solids coating (a form of liquid coating in which the liquid portion is small and the solids content is high); or as a powder (where there is virtually no solvent).

Paint application methods are by either spray or dip, or some variation thereof. Application may be manual or automatic. The major quantities of hazardous wastes are generated in the spray application method. Other techniques may generate minor quantities of wastes from clean-up between paint batches, spills, accidents and paint overspray.

There are six basic paint application techniques(1):

1. Spray Painting: Liquid spray painting is presently the most common application method and may be used with almost all varieties of paint to coat almost all types of materials. Varieties of spray application include air spray, airless spray, hydraulic spray, electrostatic spray and disc spray. All of these methods are amenable to automation and are currently in widespread use. In all cases, the

painting is accomplished by driving finely divided particles onto a workpiece. The particles may be atomized from a liquid by an atomizing spray gun, or they may be finely divided solid particles that are electrostatically charged at the spray gun and attracted to the piece to be coated.

Spray painting may also be done with powder. Powder overspray is generally collected and returned to the paint supply. However, powder overspray is occasionally intercepted by a water curtain, or collected dry and discarded.

2. Flow Coating: Flow coating is used to apply paint to materials of simple shape hung from conveyor lines. Paint flows under low pressure onto the parts. Excess paint is collected and recycled.
3. Dip Coating: Dip coating consists of submerging and withdrawing parts from a paint tank. Paint deposited on areas where it is not desired is removed with a water spray. The resultant waste may then be directed to the plant central wastewater treatment system, where it is removed along with sludge from other manufacturing processes.
4. Electrodeposition Coating: Electrodeposition (EDP) coating is used primarily to apply primer coats in the auto industry. It is a fast process which gives a fairly thick, highly uniform corrosion resistant coating.

The finishes produced by electrodeposition are not glossy. Therefore, spray painting is generally used for the final coat. In electrodeposition, parts which are immersed in a paint/water emulsion bath are coated by electrochemical action. The emulsion bath is continuously recirculated through an ultrafilter to remove impurities (which pass through the membrane into the permeate) and to provide rinse water. The permeate is split into a blowdown stream and a rinse water supply stream. The permeate stream is free of suspended solids, but if the blowdown portion is treated for dissolved heavy metals removal before discharge, some heavy metal sludge will result. After painting, the parts are rinsed first with ultrafiltration permeate and then usually with deionized water. The permeate rinse drainage is usually recirculated to the EDP paint bath, but the final, deionized rinse drainage is usually discharged. If treated before discharge, a very small quantity of paint solids may be removed from the water.

5. Fluidized Bed: The fluidized-bed process is used to apply powder coating. In this process, powder is first placed on a perforated plate forming the

bottom of a coating enclosure. Air is then blown into a chamber under the plate, fluidizing the powder. Coating occurs through heating or electrostatic means. In heating, the workpiece to be coated is heated to temperatures above the fusion point of the powder. The part is then dipped into the powder cloud and becomes coated as the powder melts on the surface of the workpiece. In an electrostatic fluidized bed, an electrode connected to a variable dc-voltage source is immersed in the powder. The charged particles of powder are attracted to the grounded workpiece and coat the surface.

6. Barrel Coating: Barrel coating is a means of coating batches of small objects, such as buttons or hardware. The parts are placed in a small cement mixer-like hopper and a carefully measured amount of paint is added. Fast drying paints, such as nitrocellulose lacquers are generally used. Drying is usually carried out in the hopper by continuing rotation with air injection.

III. WASTE GENERATION AND MANAGEMENT[1]

A. General Source of Waste

In the above paint application techniques, the rate of generation of hazardous waste will vary with the process used, while the actual contaminants generated will vary with the type of coating selected.

The paint use efficiency of several application methods is shown below(1):

Method	Efficiency
Conventional air spray	20 - 75%
Powder application	up to 99%
Dip coating	75 - 90%
Electrodeposition	90 - 96%
Electrostatic spray	up to 90%

Powder coatings are most efficient and have several advantages over liquid coatings. In powder coatings, virtually no solvents are used. Therefore, exhaust to the outside can be eliminated and instead, the air can be filtered and returned to the paint room. In addition, the dry powder overspray may be filtered out, eliminating the need for water or oil curtains. In some instances, the reclaimed powder coat can be reused after filtering and screening(1).

Liquid spray painting accounts for the majority of solid waste discharges within the industry. The source of waste solids in this process is overspray -- the paint which misses the object being painted. Overspray is intercepted by paper curtains or liners, by dry filter arrestors (which pass ventilating air), by water curtains, or by oil curtains. The paper curtains and dry filter arrestors are periodically disposed of as trash. Water and oil curtain interceptors rely on the circulation of water or oil continuously from,

and back to, sumps under the spray paint booths. The oversprayed paint solids are periodically removed from the sumps either manually or automatically. These wet solids are disposed of with the plant trash for removal by a contractor.

Some facilities discharge solids from paint booth sumps to an on-site wastewater treatment system. The paint solids, along with solids from other manufacturing processes, are then settled out as sludges in solids separating chambers such as clarifiers, settling tanks, and lagoons. All sludges are removed by contact haulers and disposed of in landfills.

B. Collection of Paint Residues

Paint booths are used to catch the excess paint overspray from a spray painting operation and to remove solvents in the air exhausted from the booth. The four common types of spray booths used in the spray painting industry and the associated wastes are described below.

1. Water-Wash Booths: Water-wash booths are common where there is a large volume of exhaust and overspray. Water reservoirs and water curtains are used to collect the excess paint and solvents. These booths are often tunnels, i.e., enclosed on the bottom, top, and sides. In a down-draft booth, where air flow is from top to bottom, the overspray is sucked down through a metal grating and into the water flowing below. Down-draft

booths are useful for large objects painted on more than one side, e.g. auto bodies. Through the addition of chemicals called paint killers, the overspray caught by the water may be made to float or sink in the reservoir located below the spray area.

When it is not feasible to float or sink the paint in the reservoir, the wastewater may be sent through an ultrafilter to remove the paint pigments in the liquid. This technique is most applicable to waterborne paints.

Electrostatic treatment also has been successfully used to treat the recirculating wastewater. The electrostatic treater incorporates an electrode to create an electric field through which the wastewater flows. The suspended paint particles are repelled by grounded piping or tanks, thus reducing buildup. Collected paint is disposed of or, in rare cases, may be reused.

2. Oil Wash Booths: In this type of booth, a special oil is used in place of chemically treated water. The oil facilitates recovery of the paint overspray and solvents that can be subsequently collected for disposal and/or reclaimed.

3. Powder Coating Booths: A typical powder coating booth has a wall with a steep, sloping bottom to collect the bulk of the powder overspray. The exhaust air from the booth is often sent to a centrifugal separator which separates the overspray from the air. Powder is discharged through the bottom of the chamber, and the cleaned air from the first stage separator is then sent to a bag filter to remove smaller suspended particles. Some plants then use an absolute filter and return the clean air to the plant. Recovered powder generally is blended with new powder and reused.

4. Dry Booths: In manual spray operations, the dry booth is usually enclosed on all but one side. Air is exhausted through the back after passing through disposable filters or around a series of staggered plates intended to catch most of the paint overspray. Exhaust rates are high enough to draw overspray paint away from the operator. The filters or paint scrapings are usually disposed of with plant trash.

Table 1 provides disposal data for paint residues/sludges from paint booths for 10 typical industrial plants. These were the only plant files, out of 56 examined, which contained sludge data. Listed are sludge volumes (or weight), disposal frequencies, the painting process and the number of paint

booths (or other source) for each plant(1). The frequency of disposal listed does not indicate the frequency of paint booth sludge skimming (which is often daily) but rather the disposal of accumulated sludge.

TABLE 1

QUANTITIES OF PAINT RESIDUES/SLUDGES GENERATED AT 10 PLANTS

EPA Plant Identification Number	Painting Process	Waste Volume (Or Weight)	Disposal Frequency	Waste Source
1002	Electrostatic Spray (water curtain booths)	3,680 yd^3	Annually	6 Booths
1007	Airless Spray	2.97 yd^3	Annually	2 Booths
	Autodeposition	600 yd^3	Annually	2 Production lines
1014	Electrostatic Spray (water curtain booths)	49 yd^3	Annually	2 Booths
1022	Spray Painting (water curtain booths)	25 yd^3	Biweekly	9 Booths
1024	Electroless Spray	1.38 yd^3	Monthly	4 Booths
	Dip Coating	0.27 yd^3	Monthly	2 Tanks
1025	Electrostatic Disc Powder Spray	20 lbs*	Weekly	--
1028	Electroless Spray (water curtain booths)	1,000 lbs	Weekly	--
1030	Electrostatic Spray (water curtain booths)	792.24 yd^3	Annually	7 Booths
1033	Electrostatic Spray (oil curtain booths)	1 yd^3	Monthly	6 Booths
1034	Electrostatic Spray (water curtain booths)	24.75 yd^3	Annually	1 Booth

(Approximately 5,830 yd^3; average of 1,416,000 lb per plant)

*Weight includes disposable filter plus adhering paint overspray.

IV. HAZARDS POSED BY THE WASTE

1. Paint Residues/Sludges

These wastes are believed to frequently contain significant concentrations of the toxic metals cadmium, chromium, and lead, and the organic compounds toluene and tetrachloroethylene, and cyanides. The source of these toxicants is the paint itself. The primary source of data supporting this conclusion is data compiled from state hazardous waste manifests.(5) This data shows these substances present in paint residues*, generally in very high concentrations (in some cases over 1% of the total waste, as in manifest numbers 3, 4, 5, 6, 7, 9, 10, 12, 17, and 19). Furthermore, in many cases, accompanying leachate extraction data shows that the toxic constituents are present in the waste in a highly mobile form, in some cases several orders of magnitude greater than the applicable National Interim Primary Drinking Water Staandard. See manifests numbers 9, 10, 16, 17 and 19. It should also be noted that the generators of these wastes themselves consider their wastes to present "high ingestion toxicity", "high dermal toxicity", as in manifests numbers 11, 12, 14, 15, 16, 17, 20, 21, 22, 23, 24 and 25.

These data are presented below:

*Termed "sludges" in many of the manifests, although it is clear from the context that the wastes in question are paint residues, not wastewater treatment sludges.

1. State: Illinois

Source: Special Waste Disposal Applications

SIC: 3573

Waste Name: Solvent based paint sludge from the manufacture of electric computer equipment

Quantity: 1500 gallons (semi-solid)

Percent Analysis: 39% water

Chemical Analysis:	Total concentration (ppm)	Leachate concentration (ppm)
Cd	2.0	0.2
Cr	150	2.0

2. State: Iowa

Source: Reports of Special Waste, Iowa Department of Environmental Quality

Waste Name: Wall water spray booth paint sludge

Quantity: 365,200 lbs/year (sludge)

Chemical Analysis:

Metal	Leachate Concentration (mg/l) (Deionized water)	Leachate Concentration (mg/l) (pH = 5.5)
Pb	5.805	5.33

3. State: Kansas

Source: Industrial Waste Disposal Requests, Kansas Department of Health and Environment

Waste Name: Paint Sludge from overspray in spray booth in the manufacture of office furniture.

Quantity: 15-20 drums/mo.

Quantitative Analysis:	Metal	Total Concentration (ppm)
	Cd	10,400
	Cr	2,900

4. State: Kansas

Source: Industrial Waste Disposal Requests, Kansas Department of Health and Environment

Waste Name: Paint solids from water wash booths

Quantity: 400 bbls./year

Chemical Analysis:	Metal	Total Concentration (ppm)
	Cr	750
	Pb	3,490

5. State: Kansas

Source: Industrial Waste Disposal Requests, Kansas Department of Health and Environment

Waste Name: Paint booth waste

Quantity: 5 bbls/week (slurry)

Chemical Analysis:	Metal	Total Concentration (ppm)
	Pb	216,000
	Cr	49,000

6. State: Kansas

Source: Department of Health and Environment, Industrial Waste Disposal Requests.

Waste Name: Paint booth and machinery clean-up sludge

Quantity: 3000 gallons/month (slurry)

Chemical Analysis:	Toxic Constituent Metal	Total Concentration (ppm)
Sample #1		
	Pb	352
Sample #2		
Toluene		420,000
Sample #3		
Toluene		420,000

7. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3631

Waste Name: Paint Sludge from microwave oven manufacturing

Quantity: 40,000 gallons/year (solid)

Percent Analysis: 85% paint pigments

Flashpoint: 100°F

Chemical Analysis:	Metal	Total Concentration (ppm)	Leachate Concentration (pm
	Cr^{+6}	2,670	0.1
	Pb	130,000	0.1

8. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 2591

Waste Name: Paint Sludge from the manufacture of porch shades and venetian blinds

Quantity: 1100 gallons/year (semi-solid)

Percent Analysis: 83% water
17% naptha
20% paint pigments

Flashpoint: 80°F

Other properties: High ingestion toxicity

9. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3519

Waste Name: Paint Sludge from spray curtain

Quantity: 25,000 gallons/bi-weekly (semi-solid)

Percent Analysis: 36% solids
10% water
54% volatile solids

Chemical Analysis: Metal	Total Concentration (ppm)	Leachate Concentration (ppm)
Cr	2,500	15.0
Pb	16,500	5.0

10. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3523

Waste Name: Paint Sludge from tractor cab manufacturing

Quantity: 17,600 gallons/year (solid)

Percent Analysis: 72.5% paint pigments
27.5% water

Chemical Analysis: Metal	Total Concentration (ppm)	Leachate Concentration (ppm)
CN	150.0	--
Cr^{+6}	1500.0	1.3
Pb	9200.0	5.4

Other properties: High ingestion toxicity

11. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3523

Waste Name: Paint sludge from farm machinery manufacturing

Quantity: 2000 gallons/year (semi-solid)

Percent Analysis: 85% pigments and filler
15% organic solvent

Flashpoint: 69°F

Other properties: High ingestion toxicity

12. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3531

Waste Name: Waste paint from spray booth from tractor manufacturing

Quantity: 24,000 gallons/year (semi-solid)

Percent Analysis: 66.5% water
30% paint pigments
2% lead
0.5% chromium

Chemical Analysis:

Metal	Total Concentration (ppm)	Leachate Concentration (ppm)
Pb	19,870	1.2
Cr	4,914	1.8

Other properties: High ingestion toxicity

13. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3661

Waste Name: Oil Sludge with solvent and paint form the manufacture of telephone and telegraph parts.

Quantity: 100,000 gallons/year (liquid)

Percent Analysis: 37.6% oil and paint
58.2% solvents

Flashpoint: 100°F

14. State: Illinois

Source: Special Waste Disposal Applications, Illionois EPA

SIC: 3661

Waste Name: Caustic and paint waste from the manufacture of telephone switching equipment

Quantity: 39,000 gallons/year (liquid)

pH: 14.0

Percent Analysis: 7.6% sodium hydroxide
0.5% zinc

Chemical Analysis:

Metal	Total Concentration (ppm)
CN	200.0

Other Properties: High dermal toxicity, high ingestion toxicity

15. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 371

Waste Name: Caustic Cleaning Waste from spray booth--paint stripping operations

Quantity: 66,000 gallons/year (liquid)

Percent Analysis: 13.3% sodium hydroxide
44.7% water

pH: 12.5

Other properties: High dermal toxicity

16. State: Illinois

Source: Waste Disposal Applications, Illinois EPA

SIC: 3312

Waste Name: Paint sludge from steel manufacturing

Quantity: 8,000 gallons/year (liquid)

Percent Analysis: 82.8% paint thinners

Flashpoint: 85°F

Chemical Analysis:

Metal	Total Concentration (ppm)	Leachate Concentration (ppm)
Pb	1015.0	6.8

Other properties: High ingestion toxicity

17. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3713

Waste Name: Paint sludge from manufacture of truck and tractor cabs

Quantity: 17,600 gallons/year (semi-solid)

Percent Analysis: 61.0% paint pigments
21.0% thinner
18.0% water

Chemical Analysis:	Metal	Total Concentration (ppm)	Leachate Concentration (ppm)
	Pb	58,200	28
	Cr	8,370.0	0.1

Other properties: High ingestion toxicity

18. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3442

Waste Name: Paint waste from production of aluminum screens and doors

Quantity: 17,000 gallons/year (semi-solid)

Percent Analysis: 62.4% paint thinners

Flashpoint: 70°F

Chemical Analysis:	Metal	Total Concentration (ppm)
	Cr	322.6

19. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3443

Waste Name: Paint and thinners from water heaters and steel drums

Quantity: 20,000 gallons/year (liquid)

Percent Analysis: 62.4% paint thinners
0.3% chromium
1.7% lead
0.8% copper

Flashpoint: 70°F

Chemical Analysis:

Metal	Total Concentration (ppm)	Leachate Concentration (ppm)
Cr	2,975.0	0.2
Pb	17,393.0	182.6

20. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 2431

Waste Name: Paint pigment sludge from window from manufacturing

Quantity: 27,500 gallons/year (semi-solid)

Percent Analysis: 50% polyured resin
15% xylene
5% cellosulde acetate
29.2% pigments

Flashpoint: 80°F

Other properties: High dermal and ingestion toxicity

21. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3579

Waste Name: Waste paint sludge from the manufacture of office copying machines

Quantity: 11,000 gallons/year (liquid)

Percent Analysis: 74.6% solvents
25.1% pigments

Flashpoint: 70°F

Other properties: High dermal and ingestion toxicity

22. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3612

Waste Name: Dry paint solids from the manufacture of stores and refrigerators

Quantity: 6,600 gallons/year (solid)

Percent Analysis: 15.7% high boiler solvent
84.3% paint pigments

Chemical Analysis:

Metal	Total Concentration (ppm)
Pb	449.9

Other properties: High ingestion toxicity

23. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 2552

Waste Name: Paint sludge from the manufacture of steel office furniture

Quantity: 150,000 gallons/year (semi-solid)

Percent Analysis: 23.1% paint thinners
63% paint pigments

Flashpoint: 100°F

Chemical Analysis:

Metal	Total Concentration (ppm)
Pb	2649.0
Cr	214.0

Other properties: High ingestion toxicity

24. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 2541

Waste Name: Paint sludge from the manufacture of store furniture

Quantity: 50,000 gallons/year (solid)

Percent Analysis: 85% polyester
7% solvents
8% pigments

Flashpoint: 73°F

Other properties: High ingestion toxicity

25. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 2792

Waste Name: Paint sludge from the manufacture of paint charts and color cards

Quantity: 19,800 gallons/year (semi-solid)

Percent Analysis: 78% paint pigments
22% lacquer thinner

Flashpoint: 79°F

Other properties: High ingestion toxicity

26. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

SIC: 3352

Waste Name: Paint waste from the manufacture of aluminum coils, plates, and sheets

Quantity: 33,000 gallons/year (semi-solid)

Percent Analysis: 51.9% pigments
29.5% paint solvents

Flashpoint: 90°F

Tetrachloroethylene is not listed as a waste constituent in these manifests, although it is a constituent of concern. The presence of this constituent is shown by its presence in significant levels in untreated wastewater in a study of 14 plants undertaken by EPA (1) (see Table 2). It is believed that tetrachloroethylene would be present in solid residues in substantially higher concentrations, since the solid

TABLE 2

PRIORITY POLLLUTANTS IN WASTEWATER FROM INDUSTRIAL PAINTING[1]

	Number of Times Analyzed	Maximum Value (mg/l)
Cadmium	49	0.095
Chromium	50	101.0
Lead	50	103.5
Cyanides	41	63.0
Toluene	41	4.16
Tetrachloroethylene	41	52.0

residues are not diluted.

2. Wastewater Treatment Sludge

As described above, some generators send their process paint residues to wastewater treatment, where a sludge is generated. These sludges are expected to contain most (or all) of the contaminants found in the paints themselves. The particular constituents of concern are cadmium, chromium, lead, cyanides, toluene, and tetrachloroethylene, since as just shown, these constituents have been demonstrated to be present in significant concentrations in paint residues.

Additional data throwing some light on the constituent concentrations in these wastewater treatment sludges is presented in Table 2. This data shows the maximum concentrations of the constituents of concern in wastewater samples from 14 industrial plants performing various types of painting. This data shows chromium, lead, and cyanides present in substantial concentrations, and cadmium and the organic contaminants present in lesser concentrations. These constituents would probably be found in the treatment sludges, for the following reasons. The heavy metals are not degradable and so would be present in the sludge. Cyanides and toluene are biodegradable ordinarily only in low concentrations (although some toluene would probably volatilize and therefore would not be in the sludge).[6] Tetrachloroethylene is subject in theory to biodegradation,[6] and thus might be present in lesser concentrations in the sludge than the other constituents of

concern. However, each of these constituents would undoubtedly be present in the wastewater treatment sludge in higher concentrations than in the wastewater since the sludges that contain the toxic constituents removed from the wastewater are dewatered, and therefore, the constituents are concentrated, before disposal.

Finally, the constituents of concern are typically expected to be present in these wastes. Table 3 shows toxic constituents present in the raw materials used by the paint industry, and shows lead, chromium, cyanides, and toluene in very wide use. The use of cadmium is less prevalent, but it is still utilized by roughly 20% of paint manufacturers.

It should be noted that the Agency possesses data[3] suggesting that a great many other toxic substances are present in these wastes, specifically the toxic constituents listed in the paint manufacturing listing background document. The Agency however presently lacks reliable data as to these constituents' concentrations in industrial painting wastes. Further information as to the presence and concentrations of additional toxic constituents in these wastes is solicited.

3. Migratory Potential of Waste Constituents

The Administrator has classified these two wastes as hazardous because the Agency has reason to believe that they contain substantial concentrations of the toxic raw materials used in the formulationof paint products and therefore that the wastes pose a substantial threat to human health and the environment. Specifically, these wastes are being listed as

TABLE 3

TOXIC CONSTITUENTS IN RAW MATERIALS
USED BY THE PAINT INDUSTRY(1)

Priority Pollutant	Responders Indicating Usage of Raw Materials Containing Specific Constituents of Concern			
	Minimum		Maximum	
	No. of Plants	Percent	No. of Plants	Percent
Cadmium	260	18.9	312	22.7
Chromium	1042	75.8	1083	78.8
Lead	833	60.6	1016	73.9
Cyanides	860	62.6	1064	77.4
Toluene	961	69.6	998	72.6

*Data generated from 1374 responses to paint industry "308" survey. Since many of the raw materials included in the "308" Data Collection Portfolio can contain more than one toxic pollutant, the Agency was unable to obtain unambiguous conunts for the occurence of particular toxic pollutants. A conservative approach was taken because of this. When the Data Collection Portfolio response did not indicate clearly which toxic pollutant was in use, the Agency mad two counts - one including neither, one including both. This gave a maximum and minimum count for toxic pollutants. Twenty-eight plants did not check any boxes in the survey. It is not clear whether the respondents use none of the listed raw materials or whether they did not fil out the questionaire completely. Finally, within the group of respondersto the raw materials survey, it was found taht each raw materials question was answered poitively at least once. This indicates that the raw materials questions represented appropriate paint raw materials.

hazardous because of the presence of the following toxic constituents:

cadmium

chromium

lead

cyanides

toluene

tetrachloroethylene

Of these constituents, hexavalent chromium and tetrachloroethylene have been identified by the Agency's Carcinogen Assessment Group as possessing substantial evidence of carcinogenicity, increasing Agency concerns as to the potential of these wastes to cause substantial harm if mismanaged. Cadmium, lead and cyanides are highly toxic to man and toluene is moderately toxic by ingestion and inhalation. Under these circumstances, the Agency requires assurance that waste constituents will not migrate from the waste and persist should mismanagement occur, if the wastes are not to be listed as hazardous. Such assurance does not appear possible here since as shown below, all of the waste constituents appear quite capable of migration in substantial concentrations, and of mobility annd persistence upon environmental release.

Toluene and tetrachloroethylene are relatively water soluble (toluene - 470 mg/l at 25°C,[4] tetrachloroethylene -

150 mg/l at 25°C[8]). The heavy metals are likewise known to be capable of migration, as shown by waste extraction data (see State Manifest Data Number 9, 10, 16, 17, 19). These compounds thus present a danger of migration via a groundwater exposure pathway if exposed to a leaching media.

Toluene and tetrachloroethylene are also significantly volatile (toluene - 28.4 mm at 25°C,[4] tetrachloroethylene - 150 mm at 25°C[8]) and could pose an air inhalation hazard to environmental receptors in the vicinity of improperly disposed wastes.

These constituents are likewise capable of mobility and persistence upon environmental release. Many constituents have in fact been involved in damage incidents resulting from improper waste management, empirically demonstrating their mobility and persistence. For example, among other contaminants, tetrachloroethylene was involved in the contamination of drinking water sources in New Hanover, North Carolina.[6] Toluene and tetrachloroethylene are among the constituents present in water and air samples taken in the Love Canal area.[7] Heavy metals and cyanides likewise have been involved in numerous damage incidents from improper waste disposal.[6]

These waste constituents thus have the capacity for migration, mobility and persistence, raising the possibility of potential hazard if the wastes are mismanaged.

Ground water or surface water contamination could result, for example, if sites are selected improperly i.e.(in areas with permeable soils) or if no leachate control measures are utilized. Lagoon-disposed wastes (such as treatment sludges prior to dredging) also pose a potential for hazard because a large quantity of liquid is available to percolate through the solids and soil beneath the fill. Further, the Agency is also concerned that the lagooned wastes could contaminate surface waters if not managed to prevent flooding or total washout.

An additional consideration favoring hazardous waste status for these wastes is that they are transported to off-site disposal facilities. This increases the likelihood of their being mismanaged, i.e., uncontrolled transportation may result either in their not being properly handled during transport or their not reaching their destination at all. A transportation and manifest system combined with designated standards for the management of these wastes will greatly reduce their availability to harm to humans and the environment.

V. Health and Environmental Effects (9)

The following contaminants of paint wastes are designated as priority pollutants under Section 307(a) of the Clean Water Act:

cadmium
chromium
lead
cyanides
toluene
tetrachloroethylene

Lead is also regulated under the Clean Air Act. Proposed or final standards have been issued for most of these chemicals under the Occupational Safety and Health Act of 1970. EPA's Carcinogen Assessment Group (CAG) has evaluated several constituents of these waste streams and found sufficient evidence to indicate that chromium (Cr^{+6}) and tetrachloroethylene are carcinogens. More specific information on the health effects of these chemicals are summarized below. Additional information on the adverse health and environmental effects of these constituents can be found in Appendix A.

Cadmium

Cadmium is an extremely dangerous cumulative toxicant, causing progressive chronic poisoning in mammals, fish, and probably other organisms. The metal is not excreted.

Toxic effects of cadmium on man have been reported

from throughout the world. Cadmium may be a factor in the development of such human pathological conditions as kidney disease, testicular tumors, hypertension, arteriosclerosis, growth inhibition, chronic disease of old age, and cancer. Cadmium is normally ingested by humans through food and water as well as by breathing air contaminated by cadmium dust. Cadmium is cumulative in the liver, kidney, pancreas, and thyroid of humans and other animals. A severe bone and kidney syndrome known as itai-itai disease has been documented in Japan as caused by cadmium ingestion via drinking water and contaminated irrigation water. Ingestion of as little as 0.6 mg/day has produced the disease. Cadmium acts synergistically with other metals. Copper and zinc substantially increase its toxicity.

Cadmium is concentrated by marine organisms, particularly molluscs, which accumulate cadmium in calcareous tissues and in the visera. A concentration factor of 1000 for cadmium in fish muscle has been reported, as have concentration factors of 3000 in marine plants and up to 29,600 in certain marine animals. The eggs and larvae of fish are apparently more sensitive than adult fish to poisoning by cadmium, and crustaceans appear to be more sensitive than fish eggs and larvae.

For the protection of human health from the toxic properties of cadmium ingested through water and through

contaminated aquatic organisms, the ambient water criterion is determined to be 0.010 mg/l.

Data show that cadmium can be incorporated into crops, including vegetables and grains, from contaminated soils. Since the crops themselves show no adverse effects from soils with levels up to 100 mg/kg cadmium, these contaminated crops could have a significant impact on human health. Two Federal agencies have already recognized the potential adverse human health effects posed by the use of sludge on cropland. The FDA recommends that sludge containing over 30 mg/kg of cadmium should not be used on agricultural land. Sewage sludge contains 3 to 300 mg/kg (dry basis) of cadmium; mean = 10 mg/kg; median = 16 mg/kd. The USDA also recommends placing limits on the total cadmium from sludge that may be applied to land.

Chromium

The two chromium forms most frequently found in industry wastewaters are hexavalent and trivalent chromium. Some of it is reduced to trivalent chromium as part of the process reaction. The raw wastewater containing both valence states is usually treated first to reduce remaining hexavalent to trivalent chromium, and second to precipitate the trivalent form as the hydroxide. The hexavalent form is not removed by lime treatment.

Chromium, in its various valence states, is hazardous to man. It can produce lung tumors when inhaled, and induces skin

sensitizations. Large doses of chromates have corrosive effects on the intestinal tract and can caue inflammation of the kidneys. Hexavalent chromium is a known human carcinogen. Levels of chromate ions that show no effect in man appear to be so low as to prohibit determination, to date.

The toxicity of chromium salts to fish and other aquatic life varies widely with the species, temperature, pH, valence of the chromium, and synergistic or antagonistic effects, especially the effect of water hardness. Studies have shown that trivalent chromium is more toxic to fish of some types than is hexavalent chromium. Hexavalent chromium retards growth of one fish species at 0.0002 mg/l. Fish food organisms and other lower forms of aquatic life are extremely sensitive to chromium. Therefore, both hexavalent and trivalent chromium must be considered harmful to particular fish or organisms.

For the protection of human health from the toxic properties of chromium (except hexavalent chromium) ingested through water and contaminated aquatic organisms, the recommended water quality criterion is 0.050 mg/l. For the maximum protection of human health from the potential carcinogenic effects of exposure to hexavalent chromium through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero.

Chromium is not destroyed when treated by wastewater treatment (although the oxidation state may change), and will either pass through to the wastewater treatment effluent or be

incorporated into the wastewater treatment sludge. Both oxidation states can cause wastewater treatment inhibition and can also limit the usefulness of municipal sludge.

Chromium not passed through a wastewater treatment plant will be retained in the sludge, where it is likely to build up in concentration. Disposal of sludges containing very high concentrations of trivalent chromium can potentially cause problems in secure landfills. Incineration, or similar destructive oxidation processes can produce hexavalent chromium from lower valence states. Hexavelant chromium is potentially more toxic than trivalent chromium. In cases where high rates of chrome sludge application on land are used, distinct growth inhibition and plant tissue uptake have been noted.

Lead

Lead ingested by humans produces a variety of toxic effects including impaired reproduction ability, disturbances in blood chemistry, neurological disorders, kidney damage, and adverse cardiovascular effects. Exposure to lead in the diet results in permanent increase in lead levels in the body. Most of the lead entering the body eventually becomes localized in the bones where it accumulates. Lead is a carcinogen or cocarcinogen in some species of experimental animals. Lead is teratogenic in experimental animals. Mutagenicity data are not available for lead.

For the protection of human health from the toxic properties of lead ingested through water and through contaminated aquatic organisms the ambient water criterion is 0.050 mg/l.

Cyanides

Cyanides are among the most toxic of pollutants commonly observed in industrial wastewaters. Introduction of cyanide into industrial processes is usually by dissolution of potassium cyanie (KCN) or sodium cyanide (NaCN) in process waters. However, hydrogen cyanide (HCN) formed when the above salts are dissolved in water, is probably the most acutely lethal compound.

The relationship of pH to hydrogen cyanide formation is very important. As pH is lowered to below 7, more than 99 percent of the cyanide is present as HCN and less than 1 percent as cyanide ions. Thus, at neutral pH, that of most living organisms, the more toxic form of cyanide prevails.

Cyanide ions combine with numerous heavy metal ions to form complexes. The complexes are in equilibrium with HCN. Thus, the stability of the metal-cyanide complex and the pH determine the concentration of HCN. Stability of the metal-cyanide anion complexes is extremely variable. Those formed with zinc, copper, and cadmium are not stable-they rapidly dissociate, with production of HCN, in near neutral or acid waters. Some of the complexes are extremely stable. Cobaltocyanide is very resistant to acid distillation in the laboratory. Iron cyanide complexes are also stable, but undergo photodecomposition to give HCN upon exposure to sunlight. Synergistic effects have been demonstrated for the metal cyanide complexes making zinc, copper, and cadmium, cyanides more toxic than an equal concentration of sodium

cyanide.

The toxic mechanism of cyanide is essentially an inhibition of oxygen metabolism, i.e., rendering the tissues incapable of exchanging oxygen. The cyanogen compounds are true noncumulaive protoplasmic poisons. They arrest the activity of all forms of animal life. Cyanide shows a very specific type of toxic action. It inhibits the cytochrome oxidase system. This system is the one which facilitates electron transfer from reduced metabolites to molecular oxygen. The human body can convert cyanide to a non-toxic thiocyanate and eliminiate it. However, if the quantity of cyanide ingested is too great at one time, the inhibition of oxygen utilization proves fatal before the detoxifying reaction reduces the cyanide concentration to a safe level.

Cyanides are more toxic to fish than to lower forms of aquatic organisms such as midge larvae, crustaceans, and mussels. Toxicity to fish is a function of chemical form and concentration, and is influenced by the rate of metabolism (temperature), the level of dissolved oxygen, and pH. In laboratory studies free cyanide concentrations ranging from 0.05 to 0.15 mg/l have been proven to be fatal to sensitive fish species including trout, bluegill, and fathead minnows. Levels above 0.2 mg/l are rapidly fatal to most fish species. Long term sublethal concentrations of cyanide as low as 0.01 mg/l have been shown to affect the ability of fish to function normally, e.g., reproduce, grow, and swim.

For the protection of human health from the toxic properties of cyanide ingested through water and throguh

contaminated aquatic organisms, the ambient water quality criterion is determined to be 0.200 mg/l.

Tetrachloroethylene

Tetrachloroethylene is highly toxic via ingestion and moderately toxic via inhalation and skin absorption as well as being carcinogenic. Tetrachloroethylene has a vapor pressure of 19 mm Hg at 20°C. It is insoluble in water but soluble in organic solvents. Because tetrachloroethylene is volatile disposal of this waste is an uncontrolled manner poses risks to human health by all routes of exposure.

The prinicipal toxic effect of tetrachloroethylene on humans is central nervous system depression when the compound is inhaled. Headache, fatigue, sleepiness, dizziness and sensations of intoxication are reported. Severity of effects increases with vapor concentration. High integrated exposure (concentration times duration) produces kidney and liver damage. Very limited data on tetrachloroethylene ingested by laboratory animals indicate liver damage occurs when PCE is administered by that route. Tetrachloroethylene tends to distribute to fat in mammalian bodies.

One report found in the literature suggests, but does not conclude, that tetrachloroethylene is teratogenic. Tetrachloroethylene has been demonstrated to be a liver carcinogen in B6C3-F1 mice.

For the maximum protection of human health from the

potential carcinogenic effects of exposure to tetrachloroethylene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of tetrachloroethylene estimated to result in additional lifetime cancer risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.000020 mg/l, 0.00020 mg/l, and 0-.0020 mg/l, respectively.

Toluene

Toluene is moderately toxic by ingestion and inhalation. Because toluene is both water soluble and volatile, it may pose a threat to human health by both exposure routes, respectively. Toluene is volatile (vapor pressure of toluene is 36.7 mm at 30°C); handling and disposal of the waste may thus pose an inhalation hazard. If the waste is disposed in an unsecured landfill the toluene may be solubilized from the waste (the water solubility of toluene is 535 mg/l, and it is miscible with a variety of organic solvents) by rainfall and contaminate underlying potable groundwater sources with may pose a hazard to human health when the water is ingested.

Most data on the effects of toluene in human and other mammals have been based on inhalation exposure or dermal contact studies. There appear to be no reports of oral administration of toluene on human subjects. A long term toxicity study on female rats revealed no adverse effects on growth, mortality, appearance and behavior, organ to body weight ratios, blood-urea nitrogen level, bone marrow counts, peripheral blood counts, or morphology of major organs. The effects of inhaled

toluene on the central nervous system, both at high and low concentrations, have been studied in humans and animals. However, ingested toluene is expected to be handled differently by the body because it is absorbed more slowly and must first pass through the liver before reaching the nervous system. Toluene is extensively and rapidly metabolized in the liver. One of the principal metabolic products of toluene is benzoic acid, which itself seems to have little potential to produce tissue injury.

Toluene has been found in fish caught in harbor waters in the vicinity of petroleum and petrochemical plants. Bioconcentration studies have not been conducted, but bioconcentration factors have been calculated on the basis of the octanol-water partition coefficient.

For the protection of human health from the toxic properties of toluene ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 12.4 mg/l.

VI. Response to Comments to the Proposed Rule

Several commenters responding to the proposed Hazardous Waste Guidelines and Regulations (43 FR 58946, December 18, 1978) objected to the category "paint wastes" which appeared in §250.14(a) as a hazardous waste. The main objection was that the category was overly broad. In response, EPA has been more specific in its listing of paint wastes. The two wastes listed in this document are generated by a number of industries engaged in industrial painting. As EPA obtains more information on paint wastes, additional generic categories may be added to the hazardous waste list.

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4. Karel Verschueren, Handbook of Environmental Data on Organic Chemicals, Copyright 1977, Litton Educational Publishing.

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Inorganic Chemicals

LISTING BACKGROUND DOCUMENT

CHLORINE PRODUCTION

BRINE PURIFICATION MUDS FROM THE MERCURY CELL PROCESS IN CHLORINE PRODUCTION WHERE SEPARATELY PREPURIFIED BRINE IS NOT USED (T).

WASTEWATER TREATMENT SLUDGES FROM THE MERCURY CELL PROCESS IN CHLORINE PRODUCTION (T).*/

I. SUMMARY OF BASIS FOR LISTING

The solid wastes of concern in this document are muds from brine purification and wastewater treatment sludges from the mercury cell process in chlorine production. The toxic constituent of concern in these wastes is the heavy metal mercury.

The Administrator has determined that mercury-bearing sludges and muds resulting from the mercury cell process in chlorine production are solid wastes which may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and which therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1. These wastes are generated in large quantities and contain significant concentrations of mercury. At the present time approximately 42,000 kkg of hazardous mercury-bearing wastes are generated each year. These wastes are calculated to contain about 600 kkg of mercury. Large quantities of this highly toxic pollutant are thus available for environmental release.

2. These wastes have been involved in a number of serious damage incidents, demonstrating empirically that improper waste management may result in substantial environmental hazard.

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*/ This waste stream was not included in the initial listing, and is being initially proposed in the present document.

II. SOURCES OF THE MERCURY AND TYPICAL DISPOSAL PRACTICES

A. Industry Profile

Twenty-seven facilities, located in 16 states, are engaged in chlorine and either sodium hydroxide or potassium hydroxide manufacture using the mercury cell process.[1,2] These facilities are identified in Tables 1 and 2. In 1979, their mercury cell production capacity was reported as ranging from 36,000 to 272,000 kkg per year.[2]

B. Manufacturing Process (Modified from Reference 1)

In the mercury cell process, rock or evaporated salt is dissolved in recycled brine or in fresh water in agitated tanks to form a saturated salt brine. In plants, not using prepurified salt--most of the plants using this process--*/ this brine is purified by adding soda ash and sodium hydroxide, and in some cases barium salts, precipitating barium sulfate, and calcium and magnesium impurities of the salt as the carbonate and hydroxide, respectively. These are removed by settling and filtration; these filtered muds (A in Figure 1) constitute one of the wastes of concern. The purified brine is then fed to the electrolytic mercury cells, where it is decomposed

*/ Six facilities (listed in Table 2) use evaporated rock salt already purified in on-site diaphragm cell operations; these plants do not perform significant purification, and therefore do not generate mercury-containing brine muds.

TABLE 1

FACILITIES PRODUCING MERCURY-BEARING BRINE PREPARATION/PURIFICATION MUDS.

STATE	FACILITY	ROCK SALT SOURCE	CHLORINE CAPACITY 10^3 kkg/yr (2)	HAZARDOUS BRINE MUDS /CHLORINE CAPACITY (kg/kkg) (10,1)	HAZARDOUS BRINE MUDS TOTAL, DRY BASIS (kkg/year)
Alabama	Diamond Shamrock, Mobile	Louisiana	38	10	380
	Diamond Shamrock, Mus.Sho.	Louisiana	142	10	1,420
	Stauffer Chem., LeMoyne	Louisiana	50	10	500
Delaware	Diamond Shamrock, Del.City	New York	139	20	2,775
Georgia	Linden Prods., Brunswick	Louisiana	98	10	980
	Olin Corp., Augusta	Louisiana	100	10	1,000
Illinois	Monsanto Co., Sauget	Kansas	40	20	800
Kentucky	B.F.Goodrich, Calvert City	Louisiana	116	10	1,160
	Pennwalt Corp., " "	Ohio	109	30	3,265 (c)
Louisiana	Stauffer Chem., St.Gabriel	Louisiana	150	10	1,500
Maine	International Minerals, Orrington	New York	72	20	1,440 (c)
New Jersey	Linden Products, Linden	New York	131	20	2,620 (c)
New York	Hooker Sobin, Niag. Falls	New York and Sask.KCl (b)	59	25	1,474
	Olin Corp., Niag. Falls	New York	80	20	1,600
No. Carol.	Linden Products, Acme	Louisiana	54	10	540
Ohio	International Minerals, Ashtabula	Sask. KCl	36	30	1,088 (c)
Tennessee	Olin Corp., Charleston	Tennessee	227	30	6,803
Texas	Alcoa, Point Comfort	Louisiana	153	10	1,530
Washington	Georgia Pacific, Bellingham	Prepurif. evap.	83	0.7	58
West Va.	Linden Products, Moundsville	W.Va.	87	45	3,918
Wisconsin	BASF Wyandotte, Port Edwards	Michigan	64	45	3,020 (c)
			2028		37,871

a) The amounts of hazardous brine muds generated were calculated by multiplying the plant annual capacity (Reference #2) by the amount of brine muds generated per kkg of chlorine produced.

b) This facility uses New York rock salt and Saskatchewan potassium chloride salt in approximately equal proportions. These salts generate 20kg and 30 kg of hazardous brine muds respectively per metric ton of chlorine produced. An average value of 25 kg was used.

c) These facilities segregate the two waste streams A and B of Figure 1.

Table 2

FACILITIES WHICH DO NOT PRODUCE MERCURY-BEARING BRINE MUDS.[a]

STATE	FACILITY	MERCURY CELL CHLORINE CAPACITY 10^3 kkg/yr[b]	SALT SOURCE
Alabama	Olin Corp., McIntosh	163	Black Warrier
Louisiana	BASF Wyandotte Corp., Geismar	136	Louisiana
	PPG, Lake Charles	272	Louisiana
New York	Linden Products, Syracuse Syracuse[c]	59	New York State
Texas	Diamond Shamrock, La Porte	181	Louisiana
West Va.	PPG, Natrium	109	West Virginia
		920	

(a) These facilities use pure salt obtained from on-site diaphragm cell operations. No hazardous brine brine preparation/purification muds are generated at these plants because no purification step is needed.

(b) Information from Versar, Inc. files.

(c) Since 1970, this facility has been using pure salt from diaphragm cell operations. However, prior to 1970 brine purification operations were conducted in the mercury cell circuits so that some of the accumulated wastes from this site may be hazardous.

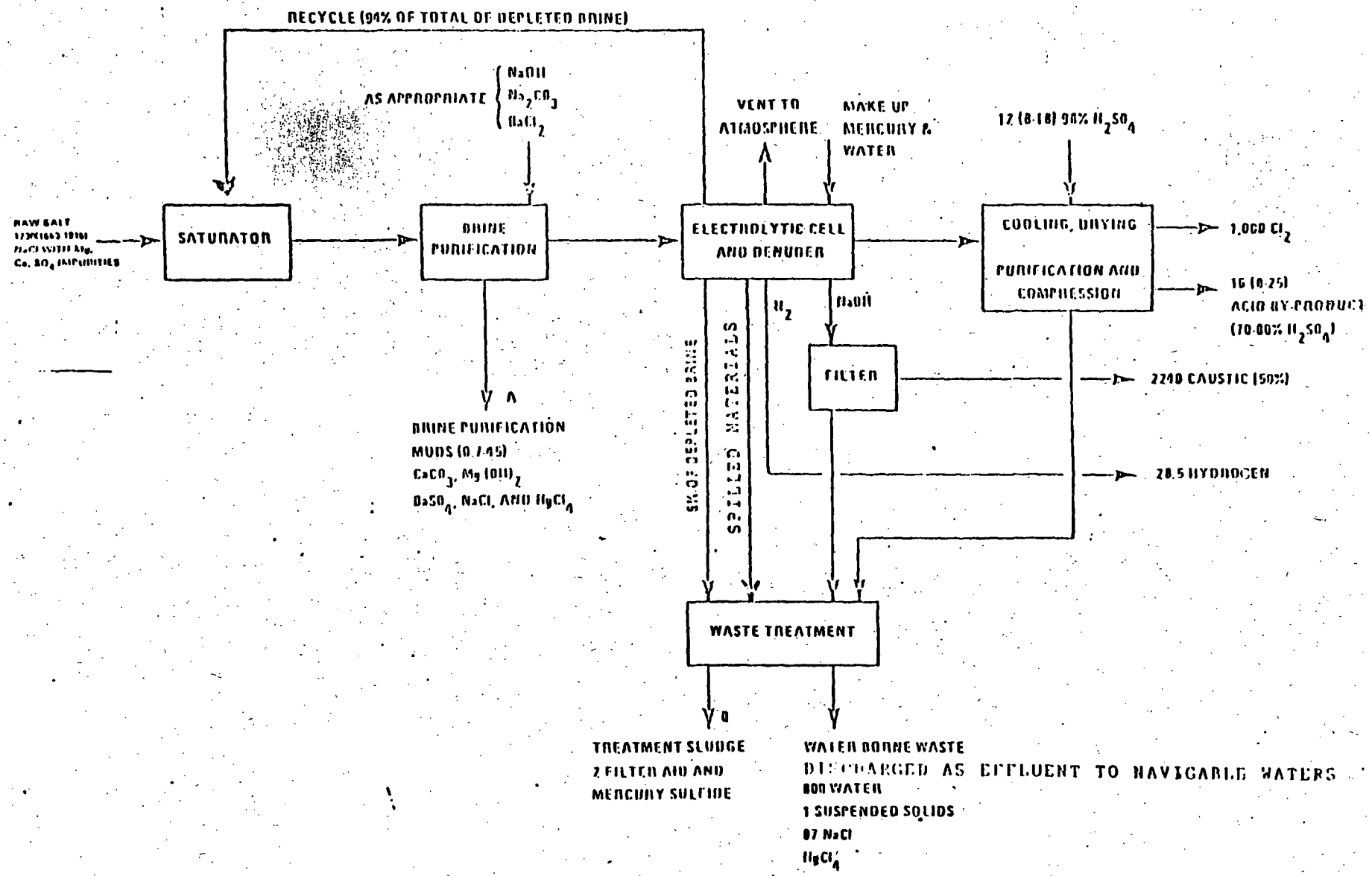

FIGURE 1 CHLOR-ALKALI MANUFACTURING BY MERCURY (1)

by electrolysis to produce chlorine and sodium amalgam. The spent brine from the mercury cells is dechlorinated and approximately 94% is returned (recycled) to the initial brine make-up for resaturation; the remainder is discharged to wastewater treatment.

Since some of the feed of the brine purifier is a mercury bearing recycle stream from the electrolytic cell, the muds (A in Figure 1) resulting from brine purification are contaminated with mercury.

In all plants, the depleted purged brines from the electrolytic cell, together with two other waste streams generated from ancillary processes, are channeled to waste treatment. Wastewater treatment generates sludges (B in Figure 1) in amounts averaging 2 kg of sludge per kkg of chlorine product.[1] These wastes, which contain about 15%* mercury (as mercuric sulfide) constitute the second waste of concern.**

The mercury leaving the cells in the form of sodium mercury amalgam is sent to denuders where the amalgam is decomposed at 80°C by the addition of deionized water. Water reacts with the sodium mercury amalgam to produce a 50 percent solution of sodium

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*This conclusion is estimated from the following factors:

(1) approximately 52 kkg of brine are used per kkg of chlorine produced[3]; about 3100 kg (6%, Figure 1) are purged[1]. These brines contain about 20 ppm of mercury[3]. Thus, 3,100 kg brines/kkg Cl_2/x20x10^{-6} kg mercury/kkg brine = 0.06 kg mercury. Since these are crude estimates, this figure is rounded to 0.1.

(2) It is estimated that about 0.3 kg of mercury are spilled per kkg of chlorine produced.[23]

(3) It is estimated that about 1.7 kkg of filter residues and occluded water are generated per kkg of chlorine produced.

Thus the treatment sludges total about 2.0 kg per kkg of chlorine; of this total 0.3 kg, or 15%, is mercury contaminated.

**The waterborne waste stream does not contain sufficient mercury to be of regulatory concern.

hydroxide* essentially free of sodium chloride. This solution is filtered to recover entrained mercury. The waste from the filtration step is sent to wastewater treatment, where mercury precipitates into the treatment sludge (stream B). Entrained mercury is removed from the hydrogen generated in the denuders, and returned to the electrolytic process. After removal of mercury, the hydrogen is either compressed for sale, used on-site, or used as a fuel. The chlorine gas collected in the electrolytic cells is cooled to condense out excess water vapor. This stream, which is essentially free of mercury, is sent to waste treatment. The partially dried chlorine is then scrubbed with 98 percent sulfuric acid to remove the rest of the entrained water vapor and is collected, compressed and liquified.

C. Waste Generation

The wastes of interest in this document are muds that result from the treatment of rock salt and recycled depleted brine, and sludges generated by the treatment of purged, depleted brines and ancillary waste streams. Twenty one facilities generate both of these wastes. Six other facilities, (those which use prepurified salt) do not generate brine purification muds (waste A, Figure 1).

*Potassium hydroxide is produced in plants using potassium chloride as raw material.

The source of mercury in the brine purification muds is the recycled brine from the electrolytic cell (which mercury is removed in the purification process step).

These brine preparation muds contain substantial concentrations of mercury, either in elemental form or as the complex ion, $HgCl_4^{=}$. Available data, in fact, indicate that the concentration of mercury in these muds ranges from 500[12] to 2000 ppm [13,14] of mercury. Total potential mercury loadings are likewise substantial: the 38,000 tons of hazardous brine preparation and purification muds generated each year (Table 1) are calculated to contain 19 to 76 kkg of mercury.

It should be noted that the amount of muds produced depends on the source of the salt used as raw material.[11,12] As indicated in Table 1, facilities using salt from the Texas-Louisiana salt dome generate about 10 kg of brine mud per kkg of chlorine. Plants using other salt sources generate brine muds in amounts ranging from about 20 kg per kkg of chlorine (salt from Kansas and New York) to 45 kg per kkg chlorine (salt from Michigan and West Virginia deposits). All the above quoted figures are on a dry-weight basis.[1,10,11,12]

The sludges resulting from wastewater treatment consist mainly of mercuric sulfide. Approximately 4,300*

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*Calculated from mercury cell chlorine production data for 1977[3] and treatment sludge data in Figure 1: 2128×10^3 kkg chlorine produced/year x 2 kkg sludge waste/ 10^3 kkg chlorine = 4256 kkg sludge waste.

kkg of this waste containing 15% mercuric sulfide (equivalent in total to 645 kkg of mercury) are generated each year.

Therefore, a total of approximately 42,000 kkg of hazardous mercury-bearing wastes containing as much as 620 kkg of mercury are generated annually from the mercury cell process. This estimate is reasonable in view of the reported 846 kkg of mercury lost to the environment as wastes and air emissions for this industry in 1965.[15]

D. Waste Management (1,11,12)

Of the 21 plants generating both listed waste streams, all but five combine their wastes prior to treatment. One plant retorts all mercury-containing wastes, eight others retort only the mercury-rich wastes, and of these eight, four store these wastes in drums until decisions are made on final disposal. One plant sends sludges to contractors for recovery. This latter disposal method is occasionally used by other facilities. Nine plants now use on-site pond storage of sludges, and seven use on-site landfill. Four plants send wastes to contractors for secured landfilling. Several plants employ combinations of these treatment and disposal techniques.*/

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*/ One plant utilizes a relatively new system for recovery of mercury from virtually all mercury bearing wastes. Treatment of contaminated wastes with sodium hypochlorite leaves wastes with a residual mercury content of less than 40 ppm. This treated waste is then disposed of by landfilling. This waste recovery process is capable of treating both brine mud and treatment sludges, and of recycling recovered mercuric chloride. However, its applicability is limited by cell design and water balance considerations.

II. DISCUSSION OF BASIS FOR LISTING

A. Hazards Posed by the Waste

The two listed wastes are of regulatory concern because of their contamination with the toxic heavy metal mercury. Brine preparation and purification muds are reported to contain as much as 2000 ppm of mercury, and treatment sludges contain about 15.0% mercury. Moreover, very large amounts of these wastes (42,000 kkg) are generated. Mercury is highly toxic to a wide variety of organisms, including man, and can accumulate in biological organisms in its various forms.

These wastes have been involved in a number of damage incidents, demonstrating empirically that improper management of these wastes may cause substantial harm. These damage incidents are described below.

- The Olin 102nd Street Landfill, Niagara Falls, Niagara County, New York.(4)

  From mid 1948 to September, 1970 Olin Chemical Corporation utilized a landfill for the disposal of chemical wastes from its Niagara Falls plant. These wastes include brine sludge from a mercury cell chlor-alkali plant plus other wastes such as chlorinated organics, lime wastes, "mu" wastes, fly ash, black cake wastes (sodium chloride, sodium chlorite, sodium chlorate, carbon, calcium carbonate, calcium hydroxide), graphite from electrolytic cells and concrete cell bodies, together

with a limited amount of research materials. This landfill is located in a suburban section of Niagara Falls, New York, contiguous to the northern shore of the Niagara River. When it was closed, the landfill was "secured" by covering the waste with a soil cover, establishing vegetation, and by constructing a dike along the Niagara River.

In 1978, a surface and groundwater sampling program was initiated at the landfill site by RECRA Research Inc. and WEHRAN Engineering Corporation[3] to provide both baseline water quality data and sufficient information to assess the impact of previous disposal operations at the site. The program included the analysis of waters from the various groundwater regimes encountered on site, and of grab samples of surface waters from the Niagara River. In view of the fact that the EPA National Interim Primary Drinking Water Standard for mercury is 2 ug/l, pertinent results indicated serious mercury contamination:

1) On one of the two dates on which samples were taken, all readings for the six Niagara River surface grab samples (taken downstream from the furthest upriver point where the landfill borders the river) contravened the Drinking Water Standard in every case, with values ranging from ^.7 to 15 ug/l. On the second date, there was no significant

difference in concentrations up- and down stream from the landfill site. On this date, stormy conditions prevailed, and the river flow was much above normal.

2) Water samples were taken from the fourteen piezometers located in the saturated water zone in the landfill. Soluble mercury readings ranged from non-detectable values to 40 ug/l, with the bulk of the readings ranging from 3.9 ug/l to 11 ug/l. Out of 14 samples taken, 13 contravened the Drinking Water Standard.

3) Contiguous to the saturated water zone of the landfill is a semi-confined aquifer of alluvial deposits. Water samples were taken from piezometers located in the alluvial deposits aquifer. Soluble mercury readings ranged from non-detectable to 35 ug/l. These data are believed to indicate that leachate from the landfill has migrated to this zone.

- The Newco Solid Waste Management Facilities, Niagara Falls, New York (5,6)

At this disposal site, Olin is currently disposing of brine sludges emanating from its mercury chlor-alkali process. (This site has been used as a waste disposal area for over 80 years.) An evaluation was performed of the presence, movement, and quality of groundwater at this facility, and the data were incorporated in a Draft Environmental Impact Statement for the State of

New York.[5,6] Elevated levels of mercury (6.6 ug/l) have been found in the leachate of mercury-contaminated sludges that have been disposed of in the landfill.

- In another damage incident[16] (involving an inactive chloralkali facility not otherwise identified in the literature), leaching of mercury from the solid wastes from the facility caused elevated levels of mercury in downstream water, suspended matter, and bottom sediment. About 39 kg of mercury are lost to water from this unlined lagoon each year. Concentration of mercury in water and suspended matter immediately downstream from the plant site are about 20 times higher than immediately upstream. The silt-clay fraction of bottom sediment immediately downstream of the plant site contains up to 200 times as much mercury as the similar sediments collected immediately upstream from this facility.[16]

- Contamination of Surface Water from an Alkali Processing Plant in Saltville, Virginia[21]:

  In another damage incident involving the Olin Corporation, an alkali processing plant generating the wastes listed in this document (and other industrial waste) disposed of these wastes in a series of lagoons located on the North Fork of the Huston River in Saltville, Virginia. Although the site (presently owned by Olin) ceased operating in 1972, wastes continue to leach from the disposal lagoons. Mercury

continues to enter the Holston River both from the site of the chlorine plant and from disposal lagoons used for disposal of chlorine production wastes. The grounds where the cell building once stood are estimated to contain some 220,000 lbs. of mercury. Cleanup costs are estimated at $32-$40 million.

The incidents described, as stated, demonstrate that mercury will migrate from this waste in harmful concentrations and reach environmental receptors causing substantial harm unless proper management is assured.

There are also other factors which warrant listing these wastes as hazardous. Transportation of these wastes to off-site disposal facilities, a management practice utilized by several manufacturers, increases the likelihood of mismanagement of these hazardous wastes, for example, due to improper handling during transport, or failure to reach the intended destination. A transport manifest system, combined with designated standards for the management of these wastes will greatly reduce their availability to do harm to human beings and the environment.

The quantity of these wastes generated is an additional factor of concern. As indicated above, these wastes are generated in large quantities (42,000 kkg of waste per year, containing 700 kkg of mercury). Under improper disposal conditions, large amounts of mercury are thus available for environmental release. The large quantities of this contaminant poses the danger of polluting large areas of ground and surface waters.

Contamination will also occur over long periods of time, since elemental mercury persist indefinitely. Since large amounts of pollutants are available for environmental loading, the attenuative capacity of the environment surrounding the disposal facility could also be reduced or used up due to the large quantities of pollutants available. All of these considerations increase the possibility of environmental exposure to the harmful constituents in the wastes.

B. Health and Ecological Effects

The various forms of mercury are interconvertible under most environmental conditions. They are toxic to a wide variety of organisms, including man,[9] and are known to accumulate in biological organisms.[9] In humans, mercurials have been associated with neurological disorders, sensory impairment and tremors. Prenatal exposure can result in impaired brain development and psychomotor disorders. Organic mercury compounds inhibit fertility, and are more toxic than inorganic forms; 0.1 ug mercury/l is toxic to freshwater crayfish.[17] Mercury is bioconcentrated 63,000-fold in fathead minnows foraging under laboratory conditions resembling those in the field.[18] EPA estimates 200 ug/day as the acceptable daily intake and, in 1973, recommended 2 ug/l as a drinking water standard [19]; in 1979 a ten-fold reduction was further recommended [20]. EPA has also recommended fresh water criteria as follows: 0.064 ug/l for inorganic mercury and 0.016 ug/l for methyl mercury [19]. Additional

information on the adverse effects of mercury on human health and the environment are documented in Appendix A.

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CHLORINATED HYDROCARBON WASTE FROM THE PURIFICATION STEP OF THE DIAPHRAGM CELL PROCESS USING GRAPHITE ANODES IN CHLORINE PRODUCTION (T)

I. SUMMARY OF BASIS FOR LISTING

Chlorinated hydrocarbons are generated during production of chlorine in diaphragm cells with graphite anodes. Purification results in separation of the chlorinated hydrocarbon waste from the product. The Administrator has determined that this waste is a solid waste which may pose a substantial hazard to human health and the environment when improperly transported, treated, stored, disposed of or otherwise managed, and which therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1. The waste contains significant concentrations of the toxic compounds chloroform, carbon tetrachloride, hexachloroethane, trichloroethane, tetrachloroethylene, dichloroethylene, and 1,1,2,2-tetrachloroethane. The Agency's Carcinogenic Assessment Group has found that chloroform, carbon tetrachloride, tetrachloroethylene and 1,1,2,2-tetrachloroethane exhibit substantial evidence of carcinogenicity.
2. Typical management practices include deep well injection and incineration. Landfilling has also been employed as a disposal method. If these practices are unregulated, hazardous substances could be released to the environ-

ment. Improper construction or operation of a deep well could cause leakage of the waste from the well into usable aquifers; inadequate incineration can result in the generation of highly toxic combustion products such as phosgene. Uncontrolled landfilling may result in migration of hazardous substances to air and ground and surface waters.

3. Most of these compounds have significant migratory potential and have proven mobile and persistent in actual damage incidents caused by imp roper waste management.

II. SOURCES OF WASTE AND TYPICAL DISPOSAL PRACTICES

A. Industry Profile

Chlorine is produced by electrolysis of brine. It is used in the pulp and paper industry, plastics, water treatment and manufacture of organic and inorganic chemicals. About 75 percent of all chlorine manufactured in the United States is produced by the diaphragm cell process.(1) Approximately 32 plants use diaphragm cells; of these, six plants that utilize graphite anodes generate chlorinated hydrocarbon contaminants.*(1) Locations and production capacities of the six are given in Table 1.(2)

B. Manufacturing Process(1,3)

Brine is purified by precipitation of metals before being sent to the diaphragm cell. Separation of solids during

*Graphite anodes predominated in the past, but in recent years most plants have replaced them with metal anodes.

Table 1

FACILITIES GENERATING CHLORINATED HYDROCARBON BEARING WASTES

PLANT/LOCATION	PRODUCTION CAPACITY 10^3 KKG/YR
ICI Americas	
Baton Rouge, LA	156
Dow Chemical	
Midland, Mich.	256
Vulcan Materials	
Denver City, Tex.	121
Champion Production	
Canton, N.C.	26
Pasedena, Tex	20
PGG Industries	
Barberton, Ohio	100

purification generates waste brine muds; the Agency has no data at this time to indicate that the brine muds are hazardous. The purified brine is heated, brought to saturation by the addition of salt and acidified. The saturated salt solution is then electrolyzed in the diaphragm cell to form chlorine, hydrogen and sodium hydroxide. Chlorine is liberated at the anode, and hydrogen and sodium hydroxide are produced at the cathode. Reaction of chlorine with carbonaceous materials in the graphite anode results in the presence of chlorinated hydrocarbon contaminants in the chlorine product.

The hydrogen is purified and either sold, vented to the atmosphere or burned. The salt solution, which has been decomposed to approximately half its original concentration, is partially evaporated to increase the sodium hydroxide concentration. During evaporation, most of the sodium chloride precipitates from the solution and is recovered in salt separators. After filtration and washing, the salt is recycled to initial brine preparation.

Chlorine is recovered from the cell and cooled to remove water and other impurities. The condensates are discharged or recycled to the brine purifier. After cooling, the chlorine gas is scrubbed with acid to remove residual water vapor. The gas is then compressed and cooled to -30°C to -45°C. At these temperatures the chlorine liquefies and is pumped to steel storage tanks. Some further purification is performed during the cooling and liquefaction process. The chlorinated hydrocarbon waste of concern is liquefied from the chlorine

gas stream during purification. Figure 1 illustrates the process.

The Agency is concerned that wastewaters from clean-out of the diaphragm cell and from caustic evaporation and salt recovery operations and sludges resulting from treatment of these wastewaters may also be hazardous because they contain significant amounts of lead. The Agency currently does not have sufficient information on the concentrations and the migratory potential of the lead in these wastes, but they may be listed as hazardous at some time in the future. Generators, however, must determine whether this waste is hazardous pursuant to §262.11 of the Subtitle C regulations.

C. Waste Generation and Management (4)

As mentioned previously, chlorinated hydrocarbon contaminants arise primarily from the reaction of chlorine with carbonaceous materials in the graphite anode. Reaction of chlorine with oils and greases in the equipment and other hydrocarbons present in the system also contributes slightly to the generation of these contaminants. The chlorinated hydrocarbon contaminants are liquified from the chlorine gas stream during purification in amounts up to 1 kg per kkg of chlorine product.

Management practices vary. Vulcan Materials Co. disposes of the chlorinated hydrocarbon waste by deep well injection, and ICI Americas Ltd. incinerates its waste.

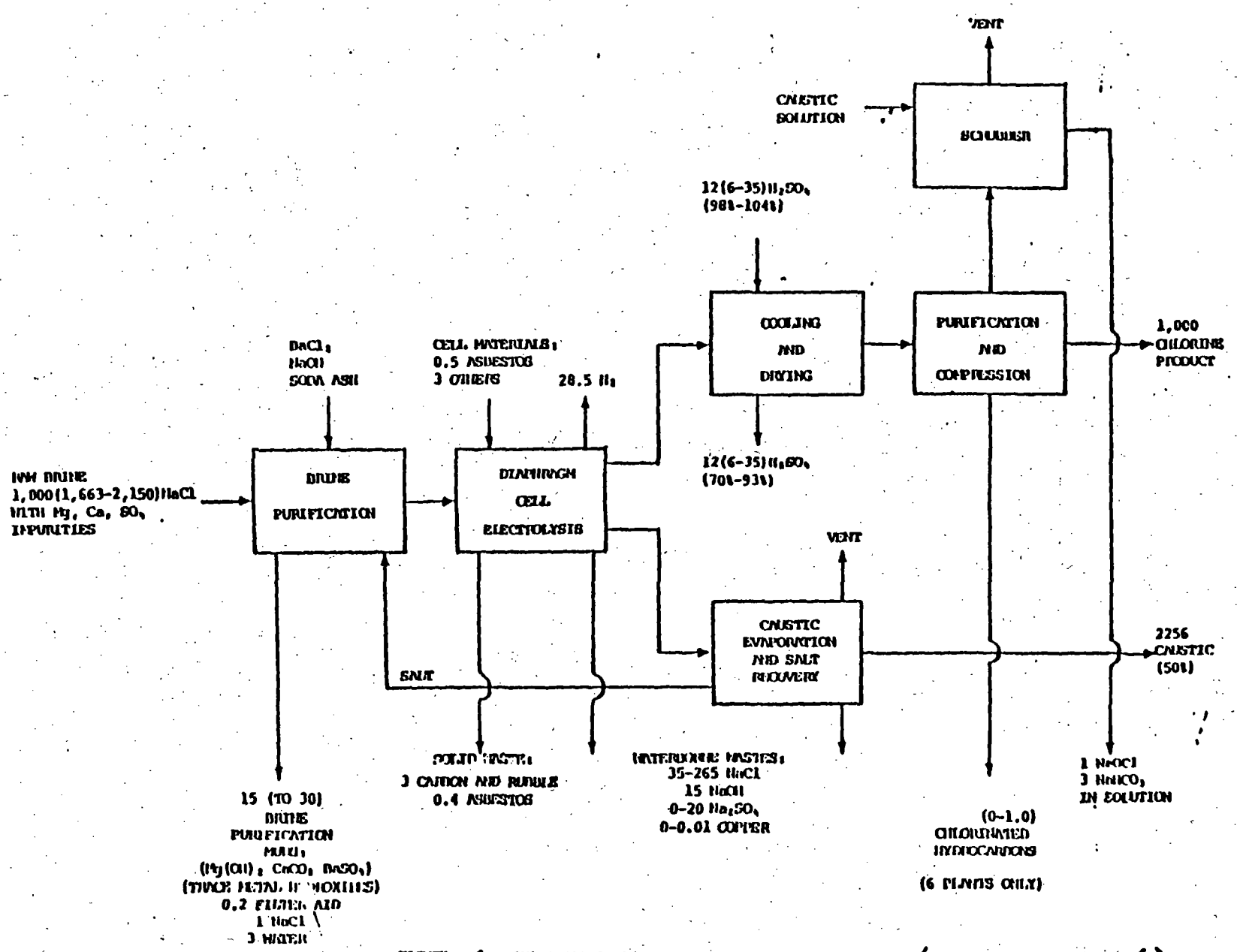

FIGURE 1. CHLOR-ALKALI MANUFACTURE DIAPHRAGM CELL PROCESS /GRAPHITE ANODES (1).

Champion International Corp. and PPG Industries, Inc., which landfilled part of their wastes in sealed drums prior to 1977, apparently do not remove the chlorinated hydrocarbon contaminants from the chlorine product at this time. Dow Chemical's management practices are not known.

III. DISCUSSION OF BASIS FOR LISTING

A. Hazards Pose by the Waste

The constituents of the chlorinated hydrocarbon waste include the following (1):

Compound Identified	Weight (%)
chloroform	73.7
carbon tetrachloride	10.8
hexachloroethane	8.0
pentachloroethane	1.3
trichloroethane	1.0
tetrachloroethylene	0.6
dichloroethylene	0.3
1,1,2,2-tetrachloroethane	0.5

Clearly, the waste contains substantial amounts of organic compounds believed to be toxic and carcinogenic. Thus, in light of these constituents' high migratory potential and their ability to persist in the environment, improper management of this waste is likely to lead to substantial hazard.

Many of the constituents of concern have high vapor pressures and thus could pose a substantial hazard to human health and the environment via an air exposure pathyway if the waste is improperly managed. Evidence available to

EPA's Carcinogen Assessment Group indicates that chloroform, carbon tetrachloride, a trichloroethane isomer, tetrachloroethylene, and 1,1,2,2-tetrachloroethane are carcinogenic. The Agency believes that the severity of the adverse health effects associated with exposure to these constituents provides a sound basis for listing the waste as hazardous. The high concentration of chloroform alone justifies the listing of this waste as hazardous, in the Agency's judgment. EPA's decision to list the waste is supported further by case histories which reveal that the hazardous constituents can migrate and persist in the environment.

Carbon tetrachloride, a major component of the waste, has been identified in school and basement air in the vicinity of Love Canal (8) and has been implicated in groundwater contamination incidents in Plainfield, Connecticut, where drinking water sources were adversely affected (9). Chloroform has been found in drinking water wells near a Jackson Township, New Jersey landfill in which chemical wastes were dumped and is known to have migrated from the Love Canal disposal site (10). Hexachloroethane, another major constituent of the waste of concern, has also migrated from at least one chemical waste disposal site (Table 7.2, Ref. 9). In addition, damage incidents compiled by EPA reveal numerous instances of environmental contamination due to migration of trichloroethane and tetrachloroethylene.(10)

An estimated 75 kkg of waste per year is disposed of in deep wells or by incineration* (2); either method may unfavorably affect human health and the environment by contaminating ground and surface waters or polluting the atmosphere. A deep well injection system that is not properly designed or operated can release hazardous constituents from the well to aquifers used as drinking water sources. Improper incineration of chlorinated hydrocarbons can result in the generation and emission of highly toxic combustion products such as phosgene (5,6,7).

Landfilling of drummed waste has been practiced in the past. This disposal method presents obvious hazards; drums are likely to corrode in the landfill and release the waste to the surrounding area. Waste contituents could then volatilize and enter the atmosphere or migrate to ground and surface waters.

Health and Environmental Effects (From App. A unless otherwise noted.)

Chloroform

Chloroform has been identified by the EPA Carcinogen Assessment Group as exhibiting substantial evidence of being carcinogenic. Due to its highly volatile nature, (App. B), improper disposal of chloroform-containing wastes may pose an air pollution hazard. Long range exposures have caused

*This number was derived by multiplying 90% of the plant nameplate capacity by 0.5, on the assumption that, on average, 0.5 kg of chlorinated hydrocarbon wastes are generated per kkg of chlorine.

both physical and neurological disorders in humans, with liver and kidney toxic responses representing the most prevalent physical pathology. FDA prohibits the use of chloroform in drugs, cosmetics or food contact material. Additional information on this substance can be found in Appendix A.

Carbon Tetrachloride

Carbon tetrachloride (tetrachloromethane) has been identified by EPA's Carcinogen Assessment Group as exhibiting substantial evidence of being carcinogenic. Its toxic effects include neurological damage and damage to the kidney and lungs. It is volatile and highly soluble in water and is therefore expected to migrate readily in the environment (11). Additional information on carbon tetrachloride can be found in Appendix A.

Hexachloroethane

Hexachloroethane is moderately toxic to humans and is one of the more toxic chlorinated ethanes to aquatic species. It appears to have the potential to bioaccumulate (App. B). Humans exposed to hexachloroethane may suffer central nervous system depression and liver, kidney and heart degeneration. It has also been shown to be carcinogenic to laboratory animals. Little information is available on its environmental fate and transport, but, due to the nature of the adverse affects associated with exposure to this compound, the Agency believes that improper disposal of a waste containing a

significant amount of hexachloroethane may pose a hazard to human health and the environment. Additional information on hexachloroethane can be found in Appendix A.

Trichloroethane

The trichloroethanes (1,1,1-trichloroethane and 1,1,2-trichloroethane) are toxic to humans, animals and aquatic organisms and have been shown to be carcinogenic in laboratory animals. Due to the toxic and carcinogenic effects of these compounds, the Agency believes that improper management of wastes which contain them may pose a hazard to human health and the environment. Additional information on trichloroethanes may be found in Appendix A.

Dichloroethylenes

Exposure to dichloroethylenes can result in adverse human health effects. The three isomers appear to have similar toxic effects, including depression of the central nervous system and liver and kidney damage (App. A). Two isomers are mutagenic in bacterial sytems and one isomer has been shown to be carcinogenic in laboratory animals (App.A). Information on environmental fate and transport is scarce but, due to the nature of the health effects resulting from exposure to dichloroethylenes, the Agency has determined that improper management of wastes containing these compounds poses a hazard to human health and the enviroment. Additional information on dichloroethylenes can be found in Appendix A.

Tetrachloroethylene

Tetrachloroethylene has been identified by EPA's Carcinogen Assessment Group as exhibiting substantial evidence of being carcinogenic. It is also toxic to aquatic species, and repeated exposure is implicated in mammalian liver and kidney damage (App.A). Little information is available concerning environmental fate and transport processes. Additional information on tetrachloroethylene is given in Appendix A.

1,1,2,2-Tetrachloroethane

1,1,2,2-tetrachloroethane has been identified by EPA's Carcinogen Assessment Group as exhibiting substantial evidence of being carcinogenic. Occupational exposure has produced neurological symptoms, liver and kidney damage, pulmonary edema and fatty degeneration of heart muscle. 1,1,2,2-tetrachloride is highly soluble in water (2900 ppm) and thus has high migratory potential (11). Although environmental fate and transport processes are not well-defined (microbial degradation appears to be the only known degredation mechanism (App. B), and this process is not likely to occur under the abiotic conditions prevailing in most aquifiers), the Agency believes that, due to the severity of the health effects associated with exposure to this compound, improper disposal of the wastes in which it is contained poses a substantial hazard. See Appendix A for additional information.

The waste also contains a significant amount of pentachloroethane, a toxic chlorinated organic. At this time the Agency has not compiled data on specific health effects or environmental persistence and mobility; when the data are obtained, a document will be prepared for Appendix A.

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LISTING BACKGROUND DOCUMENT

TITANIUM DIOXIDE PRODUCTION

Wastewater Treatment Sludge From the Production of Titanium Dioxide Pigment Using Chromium Bearing Ores by the Chloride Process (T)

Summary of Basis for Listing

Process wastewaters from the production of titanium dioxide (TiO_2) by the chloride process contain oxides and chlorides of chromium and other metals that are present in the ore as contaminants. Treatment of these wastewaters prior to discharge generates a sludge that is usually discarded. The Administrator has determined that this wastewater treatment sludge may be a solid waste, and as a solid waste may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1. The waste contains significant quantities and concentrations of the toxic heavy metal chromium. It is estimated that more than 600 kkg of chromium are contained in the 800,000 kkg of these water treatment sludges produced each year, and that chromium concentratons in the sludge range from 500-12,000 ppm.

2. Chromium is capable of migrating from the waste if improper management occurs, and may be highly mobile upon release. Improper disposal of this waste thus may result in the release and migration of the chromium which may then contaminate ground or surface waters.

3. Five of the eight plants generating this waste currently dispose of their wastes in uncontrolled landfills [1], thus posing a realistic possibility of migration of chromium to underground drinking

water sources. Further, chromium persists virtually indefinitely so that the danger of contamination is long-term should migration occur.

4. Very large quantities of this waste (800,000 kkg) are generated annually and are available for disposal as solid waste. There is thus greater likelihood of large scale contamination of the environment if the waste is not properly managed.

II. Sources of Waste and Typical Disposal Practices

A. Industry Profile

TiO_2 is a high volume chemical, ranking in the first fifty of U.S. chemicals production. More than fifty percent of the TiO_2 produced is used in paints, varnishes and lacquers. About one-third is used in the paper and plastics industries. Other uses are found in the manufacturing of ceramics, ink and rubber. About 610,000 kkg were produced in 1972.(2) It is manufactured by either the sulfate or chloride process; the latter accounts for 65% of production capacity (see Table 1). This document discusses the wastes generated by the chloride process, wastewater treatment sludge being the waste of concern.

The chloride process uses rutile or upgraded ilmenite ores as raw materials. The chromium content of these ores varies considerably. Australian rutile typically contains 0.19% chromium oxide (6,7) and those ilmenite ores used in U.S. TiO_2 production (New York, Florida and Canadian ores) contain up to 0.15% chromium oxide.(6,7) However, the ores have been reported to contain as much as 4.0% chromium.(15)

Table 1 TITANIUM DIOXIDE PRODUCERS (CHLORIDE PROCESS)[1]

Manufacturer	Location	Capacity kkg/yr
E.I. DuPont de Nemours Co., Inc.	Antioch, California	27,200
	New Johnsonville, Tennessee	207,000
	Edgemoor, Delaware	99,000
Kerr-McGee Corp.	Hamilton, Mississippi	45,000
SCM Corporation	Baltimore, Maryland	26,300
Glidden-Durkee Division	Ashtabula, Ohio	24,500
New Jersey Zinc	Ashtabula, Ohio	27,200
American Cyanamid	Savannah, Georgia	36,400
	Total	492,600

B. Manufacturing Process [1,8] (see Figure 1 for Flow Chart)

In the manufacturing process, the raw ore is first dried. Dried ore, dried coke and gaseous chlorine are then charged to a heated continuous fluidized bed chlorination reactor, converting the titanium oxide in the ore to titanium tetrachloride by the following reaction:

$$3C + 2TiO_2 + 4Cl_2 \xrightarrow{800\text{-}1000^\circ C} 2TiCl_4 + CO_2 + 2CO$$

The gases leaving the chlorinator consist of titanium tetrachloride, unreacted chlorine, carbon dioxide, carbon monoxide and volatile heavy metal chlorides generated by the reaction of chlorine with metallic impurities in the ore. These gases are subjected to a purification step involving cooling, condensation, and separation of the heavy metal impurities, specifically the chlorides of vanadium, zirconium, chromium and other trace heavy metals, silicon, and titanium. This process stream is labeled "A" in Figure 1.

This purification step is of special importance for purpose of this document, because it is the point in the process where chromium enters the solid waste stream. More importantly, virtually all of the chromium impurities in the raw ore are removed at this point in the process and, as explained below, are therefore likely to be present in the wastewater treatment sludge. The residual uncondensed gases consisting of unreacted chlorine, hydrochloric acid, traces

information supplied by industry plants, based on 1974 production, and ver ed on a follow-up basis for accuracy ough 1977;

*the quantity of chromium in waste stream A (as chromium chloride) is approximately the same regardless of ore type, due to the different quantities of each ore type required to produce the same quantity of product, and the differing percentages of chromium (as chromium oxide) in each type of ore.

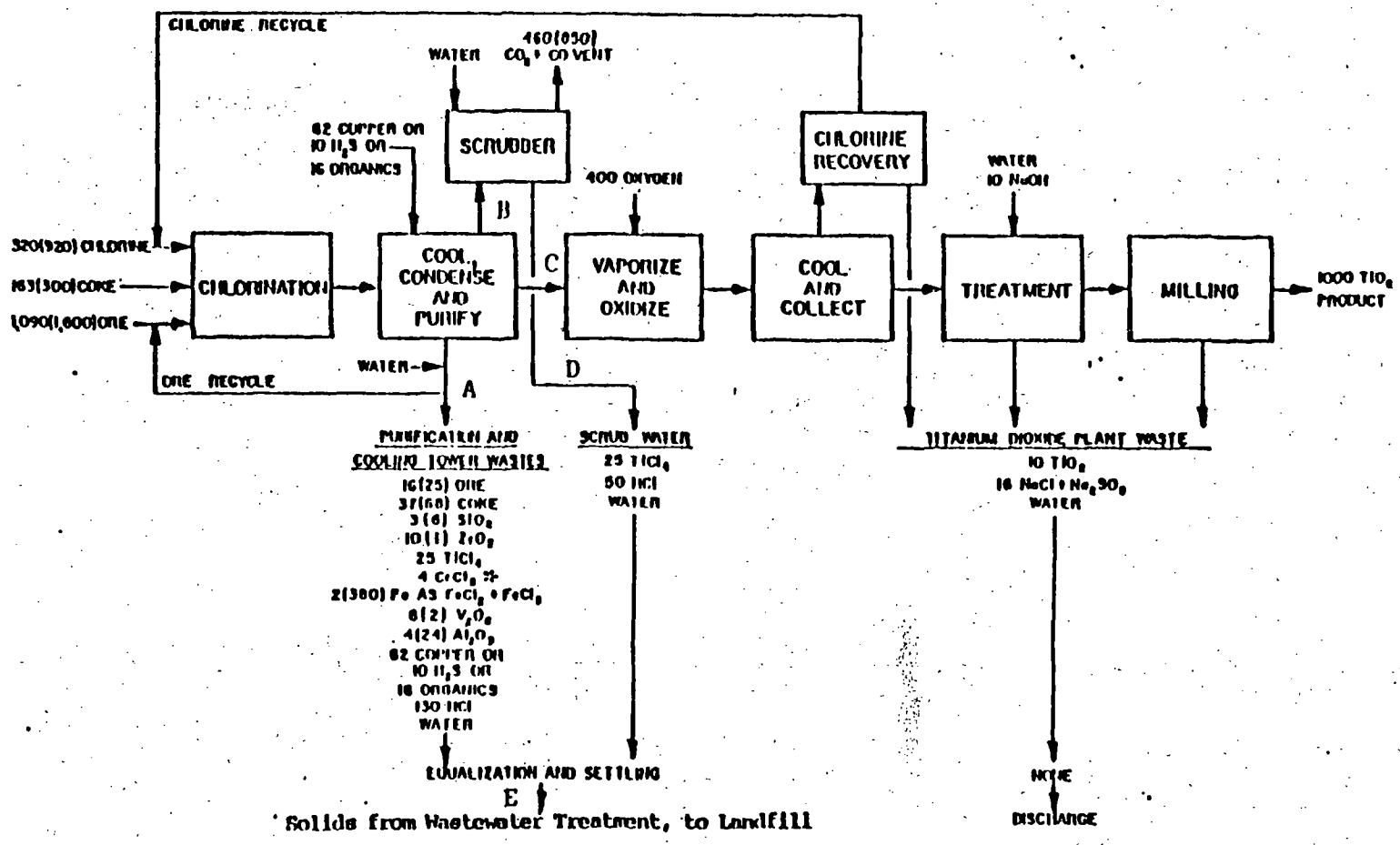

FIGURE 1
TITANIUM DIOXIDE MANUFACTURE
BY THE CHLORIDE PROCESS USING RUTILE ORE OR ILMENITE ORE* *

NOTE: figures in parentheses are for ilmenite ores

of phosgene, carbon monoxide, carbon dioxide, titanium tetrachloride and nitrogen pass to the scrubber (stream B, Figure 1), where they are scrubbed (cleaned) by a two-step process. The waste resulting from this process is labelled "D" in Figure 1.

This stream (D) is not reported to contain chromium, this element having been removed by the purification step. The Agency believes, however, that trace amounts of chromium are present in this stream, but (as stated below) since this stream is combined with stream A prior to sludge generation, the fact is not of regulatory significance.

The remaining reactor condensate (stream C, Figure 1) is purified, vaporized and reacted in special burners with oxygen (or air) to form the product titanium dioxide:

$$TiCl_4 + O_2 \longrightarrow TiO_2 + 2Cl_2$$

The resulting gas-solid mixture is cooled to near ambient temperature, and the solid titanium dioxide is separated from the gas phase by proprietary dry collection methods. The residual gas stream is further cooled to recover chlorine, which is recycled to the chlorinator. The tail gases are released to the atmosphere after chlorine recovery is completed.*/

*/There is a product washing step (labelled 'treatment' in Fig. 1) which deacidifies the product. A separate waste stream is generated at this point, which is not believed to be hazardous, and further is believed to contain only insignificant amounts of chromium.

C. Waste Generation

The waterborne waste streams A and D are typically combined (equalized) and neutralized, then lagooned to settle the suspended solids prior to effluent discharge.[8] The resulting sludge (E in Figure 1) is the waste of concern in this document. Chromium is the waste constituent of concern. Chromium is present in the process wastewater mostly as the chloride (some unreacted Cr_2O_3 is also present), both predominantly as the trivalent species. When the wastewater is neutralized, chromium hydroxide is formed. Unreacted chromium chloride is expected to be entrained by the hydroxide precipitate. The relative concentrations of the two chromium compounds will depend in part on the efficiency of the neutralization step.

The Agency believes chromium concentrations in the waste to be substantial. Estimated chromium concentrations for sludges from processes using rutile and ilmenite ores are presented in Table 2 below, and indicate that elemental chromium concentrations in the treatment sludge are significant: approximately 12,000 ppm when rutile ore is the feed material, and approximately 500 ppm when ilmenite ore is used. These are derived figures, and the full basis for the derivation is set out in Appendix 1. The assumptions made for this derivation are as follows:

--The chromium oxide content of the feed ores are 0.15% for ilmenite ores, based on typical values (see p. 3 above).

Since significantly higher chromium concentrations have been reported (id.), this is believed to be a conservative assumption.

--Virtually all of the chromium in the ore will be removed during the process purification step. This assumption is somewhat agressive, but is believed to be realistic, since the purification step is designed to remove heavy metal impurities, and moreover, available sampling data (1, as presented in Fig. 1) indicates all chromium being removed at this point in the process. Although small amounts of chromium may remain in the product, or are removed in the product washing step of the process, these amounts are believed to be insubstantial, and not of regulatory significance.

--All of the chromium present in the process wastewater (combined streams A and D in Fig. 1) will precipitate and will therefore be present in the wastewater treatment sludge. This assumption is also somewhat aggressive, since some traces of chromium may be discharged in the effluent. The overwhelming percentage, however, will not be so discharged (because of the relative insolubility of chromium hydroxide). Since elemental chromium is non-degradable, it will persist in the treatment sludge and in leachates therefrom.

Using these assumptions, chromium concentrations in the treatment sludge are derivable by first determining the respective total TiO_2 production from ilmenite and rutile ores, by determining the quantity of each ore required to generate this amount of product, determining the quantity of chromium oxide in this amount of ore and by converting this value into chromium (since virtually all chromium in the ore is assumed to be present in the wastewater treatment sludge).

Total potential waste loadings are quite substantial. It is estimated that rutile ores generate approximately 0.055 kkg of waste per kkg of product whereas ilmenite ores generate between 2.23 and 3.40 kkg of waste per kkg of product (1,7). As shown in Table 2, the total quantity of wastewater treatment sludge generated from this process is estimated to contain over 600 kkg of chromium. Another report (8) estimates the generation of 1.4 kkg chromium per 10^3 kkg of product resulting in a similar figure for total chromium in the waste.

D. Waste Management

Current practices in this industry for the management of this waste are as follows:[1]

- One plant disposes of the waste on-site in lined lagoons (with monitoring).
- One plant disposes of most of the waste by deep well injection (with monitoring).
- Two plants transport the waste off-site to a common unlined landfill (no monitoring).[7]

Table 2

QUANTITY OF WASTEWATER TREATMENT SLUDGE GENERATED BY THE TITANIUM DIOXIDE CHLORIDE PROCESS AND CHROMIUM CONTENT OF THE WASTEWATER TREATMENT SLUDGE

State	Number of Plants	Capacity[1] kkg/yr	Ore Used	Sludges Generated (Dry basis)[7] (kkg/yr)[1]	Chromium in Sludge (dry basis)%*	Total Chromium in Wastewater Treatment Sludge (Dry) (kkg/yr)
California	1	27,200	Rutile	1,500	1.23	18
Delaware	1	99,000	Ilmenite	337,000**	0.051	171
Georgia	1	36,400	Rutile	2,000	1.23	24
Maryland	1	26,300	Rutile	1,800	1.23	22
Mississippi	1	45,000	Rutile	2,500	1.23	30
Ohio	2	51,700	Rutile	9,700	1.23	116
Tennessee	1	207,000	Ilmenite	461,000	0.051	235
Totals	8	492,600		815,500		616

* See Appendix I for calculations.

** Of this quantity, up to 150,000 kkg per year is sold as $FeCl_3$.

- One plant transports the waste off-site to an unlined landfill.
- Two plants combine the chloride process wastewater with that from titanium dioxide sulfate process operations. One plant neutralizes this combined wastewater prior to discharge and disposes of the solids in an on-site landfill. The other facility neutralizes only part of its wastewater and uses contractors to transport the formed solids off-site to a landfill.
- One plant sells a portion of its waste as ferric chloride (as much as 150,000 kkg per year) and disposes of the remainder by ocean barging.*/

III. Discussion Basis for Listing

A. Hazards Posed by the Waste

As shown above, chromium may be present in this waste in substantial concentrations, from roughly 500-12,000 ppm. Chromium is present in the wastewater treatment sludge primarily as the trivalent species, principally the hydroxide and also as the chloride. Depending on the presence of other metal ions, and the acidity or alkalinity of the specific

*/Under §261.6 (which applies to sludges which fail a characteristic, as well as to listed wastes) this reused hazardous waste is subject to the requirements of Subtitle C up to the point of actual reuse. (See also 45 Fed. Reg. at 33092-094 (May 19, 1980) for a more detailed explanation of the current regulatory regime for reused hazardous wastes).

environment, oxidation to higher valence states will occur. Thus, these wastes may, after storage or disposal, contain chromium generally in the most stable tri- and hexavalent states. Both forms of chromium are toxic, though hexavalent chromium is more toxic and is an animal carcinogen.(9)*/ Section III B of this document discusses more fully the health and ecological effects of chromium.

The chromium components of this waste are capable of migration, mobility and persistence. Neutralization of the TiO_2 wastewater stream results in the precipitation of chromium as the hydroxide. Chromium hydroxide has limited migratory potential due to its low solubility (see Water Related Environmental Fate of 129 Priority Pollutants, supra, Vol. 1, Ch. 10).

However, chromium was shown to be extractable from an electroplating wastewater treatment sludge (in which chromium is present in the hydroxide form). Chromium leached from waste samples subjected to the proposed extraction procedure in concentrations as high as 400 mg/l, demonstrating ability to migrate in relatively mild acidic environments. (see listing background document, "Electroplating and Metal Finishing Operations.")

*/See EP Toxicity Background Document at pp. 109-112 summarizing data showing that trivalent chromium is likely to oxidize to the more dangerous hexavalent chromium upon environmental release, even in mild environmental conditions. Thus, exposure to hexavalent chromium is possible even if chromium migrates in the trivalent state. To the same effect, see Water-Related Environmental Fate of 129 Priority Pollutants, Vol. 1, U.S. EPA 1979, Ch. 10, at 10-3.

In addition, chromium was shown to be extractable from a neutralized spent pickle liquor sludge sample (in which chromium is present in the hydroxide form), in concentrations (429 ppm) sufficient to create substantial hazard [18] (see listing background document "Steel Finishing").*/ Thus chromium, even when present as the relatively insoluble hydroxide, is capable of migrating from neutralized sludges. An acidic environment can reasonably be expected to occur in the waste management practices for titanium dioxide wastewater treatment sludges. Such an environment could result from inadequate neutralization of the acidic waste stream, from co-disposal of neutralized sludges with acidic wastes, or as a consequence of disposal in areas subject to rainfall. Seven of the eight TiO_2 facilities are located east of the Mississippi, in areas where rainfall is becoming more acidic.[4,5].

An additional consideration is the probable presence in the waste of chromium as the chloride. It is expected to be entrained by the precipitated chromium hydroxide, and may, in fact, be present in high concentration if the wastewater is not efficiently or adequately neutralized. Chromium chloride is extremely soluble (430,000 mg/l), and thus has very high migratory potential.[16]

*pH and test conditions unknown

Improper management of this wastewater treatment sludge may consequently result in ground- and surface water contamination. Sludges accumulate in the bottom of wastewater treatment lagoons and remain there until dredging and final disposal. Chromium could leach out and contaminate groundwater if lagoons are unlined or lack adequate leachate collection systems; moreover, as shown on p.11 supra, few facilities use liners or collection devices in managing this waste. In addition, migratory potential of the waste would increase under acidic conditions. The solubilities of the different species of chromium differ but in general increase with acidity.(3) Thus, though chromium has the ability to migrate under mild conditions, its ability to do so increases significantly with a decrease in pH. Accordingly, if the wastewater -- which, as Figure 1 illustrates, contains significant concentrations of HCl -- is poorly neutralized, the soluble chromium constituents in the waste are likely to remain in solution or be entrained in the precipitated sludges, resulting in increased migratory potential of chromium ions.

There is also a danger of migration into and contamination of surface waters if lagoons are improperly designed or managed. Thus, inadequate flood control measures could result in washout or overflow of ponded wastes.

As previously stated, five of the eight facilites which produce titanium dioxide via the chloride process ultimately

dispose of their wastewater treatment sludges in off-site unlined landfills. This practice could also lead to the release of chromium from the waste and subsequent groundwater contamination. Rainfall percolating through unlined landfills may cause the chromium constituents to migrate from the matrix of the waste into the environment. This is especially likely in areas where acid rainfall is prevalent, since, as previously discussed, chromium is more soluble in acid environments. Seven of the eight plants manufacturing titanium dioxide are located east of the Mississipi, in area of the country where rainfall is becoming more acidic.([4,5]) If these unlined treatment or disposal facilities are located in areas with permeable soils, the potential for groundwater contamination would be even greater.

In addition to difficulties caused by improper site selection, uncontrolled landfills are not likely to have leachate control practices or surface run-off diversion systems that are sufficient to diminish or prevent leachate percolation through the soil underneath the site to groundwater. It should also be noted that two of the sites currently employ groundwater monitoring at existing on-site disposal facilities, which would indicate their concern for the management of these wastes (i.e., the fact that they may pose a hazard of groundwater contamination).

With regard to the fate of chromium, the heavy metal contaminant present in the waste is an element which persists

indefinitely in some form and therefore may contaminate drinking water sources for long periods of time.

The Agency has determined to list wastewater treatment sludge from the production of TiO_2 pigment using chromium bearing ores by the chloride process as a T hazardous waste, even though the waste may be evaluated by the E characteristic, and even though chromium concentrations in the EP extract from this waste from individual sites may not always be 100 times the national interim primary drinking water standard. The Agency believes that there are other factors in addition to the metal concentrations in a waste extract which justify the T listing. Some of these factors already have been identified, namely that chromium is believed to be present in the waste in high concentrations, that present industry disposal practices may sometimes be improper, that the location of most of the disposal sites are in areas of acid rainfall and so may increase the potential of chromium to leach from the waste, and that chromium will persist indefinitely in some form in the environment.

The quantity of the waste, is an additional supporting factor in the listing of this waste as hazardous. As indicated above, these wastewater treatment sludges are generated in large quantities (800,000 kkg/yr) and contain large amounts of the constituent of concern (>600 kkg). These large quantities of chromium pose the danger of large scale contamination of ground and surface water should mismanagement occur. Addi-

tionally, since these wastes are disposed of at relatively few disposal sites, the chance for environmental insult increases in these areas. For example, it is calculated that approximately 230 kkg of chromium will be disposed of annually at a single site. Further, should contamination occur, it will be for long periods of time, since chromium persists virtually indefinitely. Attenuative capacity of the environment surrounding the disposal facility could also be reduced or used up due to the large quantities of pollutant available. All of these considerations increase the possibility of exposure to the harmful constituent in the waste, and, in the Agency's view, support a T listing.

B. Health and Ecological Effects of Chromium

The hexavalent forms of chromium are more toxic than the trivalent species. Although trivalent chromium is the predominant species in the waste sludges of concern in this document, conversion of an unknown extent to the hexavalent species is expected to occur.

Hexavalent chromium is an animal carcinogen,[9] and there is some epidemiologic evidence that it may be a human carcinogen as well;[9] EPA's Carcinogen Assessment Group has listed it as such. Bacterial mutagenic effects have been reported as well as cytogenetic effects in exposed workers using hexavalent chromium compounds.[11] Trivalent chromium has not shown to be either mutagenic or carcinogenic. A single study, of doubtful significance, reported teratogenic

effects of both forms of chromium to chick embryos.[9] Other chronic effects of chromium compounds occur at very high dose levels in some industrial situations.[11]

The acute toxic effects of trivalent chromium for fish are more pronounced in soft than in hard water.[10] Hexavalent chromium, at low concentrations, is toxic to many aquatic species. For the most sensitive aquatic species, Daphnia magna, a chronic no-effect level of less than 10 ug/l has been derived.[9] Hexavalent chromium (chromate) has been reported not to bioconcentrate in freshwater fish.[10]

EPA has estimated 800 ug/l as the concentration of hexavalent chromium in ambient water which will result in a 10^{-6} risk level of human cancer. The proposed freshwater standard for hexavalent chromium is 10 ug/l, not to exceed 110 ug/l. [12]

OSHA has established 1 mg/m^3 (8 hr TWA) as the workplace exposure limit in air for chromium metal and insoluble salts, and 0.5 mg/m^3 for soluble chromium compounds.[14] Additional information on the adverse health and environmental effects of chromium are described in Appendix A.

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APPENDIX I

ESTIMATE OF CHROMIUM CONCENTRATION IN WASTEWATER TREATMENT SLUDGE FROM TiO_2 PRODUCTION (Chloride Process)

The amount of chromium in the wastewater treatment sludge is dependent upon the amount of chromium in the ore. The amount of chromium in both ilmenite and rutile ore is highly variable. In the United States, the chromium content of the ilmenite ores that are used ranges from less than 0.001% to 0.15% (1). Australian rutile ore, which is used domestically, contains about 0.19% chromium as the oxide (1). An estimate of the chromium content of the waste can be generated using these data, but it should be noted that plants can change ore source and thus their waste load. The following estimate is based upon a chrome oxide content of 0.15% for ilmenite ore and 0.19% for rutile ore. Chromium concentration in the treatment sludge can be estimated as follows:

1978 TiO_2 production = 615,853 kkg (*)

TiO_2 Chloride process capacity = 492,600 kkg (1)

TiO_2 Sulfate process capacity = 263,800 (1)

$$\text{Chloride process production} = \frac{492{,}600}{492{,}600 + 263{,}800} \times 615{,}853 \text{ kkg}$$

$$= 401{,}070 \text{ kkg } TiO_2$$

*Chemical and Engineering News, June 12, 1978, p.48.

From Tables 1 and 2:

$$\text{ilmenite production} = \frac{306{,}000}{492{,}600} \cdot 401{,}070$$

$$= 249{,}142 \text{ kkg } TiO_2$$

$$\text{thus rutile production} = 401{,}070 \text{ kkg} - 249{,}142 \text{ kkg}$$

$$= 151{,}928 \text{ kkg } TiO_2$$

A. For ilmenite ore:

$$\text{ore required}^{(3)} = \frac{1600 \text{ kkg ore}}{1000 \text{ kkg } TiO_2} \cdot 249{,}142 \text{ kkg } TiO_2$$

$$= 398{,}627 \text{ kkg}$$

Cr_2O_3 content = 0.0015 x 398,627 kkg ore = 598 kkg

Cr content = 598 x 104/152 = 409 kkg Cr

Treatment sludge from ilmenite plants = 798,000 kkg[1]

$$\text{Cr concentration in sludges} = \frac{409 \times 100}{798{,}000}$$

$$= 0.051\%$$

B. For rutile ore:

$$\text{ore required}^{(7)} = \frac{1090 \text{ kkg ore}}{1000 \text{ kkg } TiO_2} \cdot 151{,}928 \text{ kkg } TiO_2$$

$$= 165{,}600 \text{ kkg}$$

Cr_2O_3 content = 0.0019 x 165,600 kkg ore = 315 kkg

Cr content = 315 x 104/152 = 215 kkg

Treatment sludges from rutile plants = 17,500 kkg

Cr concentrations in sludges = $\frac{215 \times 100}{17,500}$ = 1.23%

Paint Manufacturing

LISTING BACKGROUND DOCUMENT

PAINT MANUFACTURING

Solvent Cleaning Wastes from Equipment and Tank Cleaning (I,T)

Water and/or Caustic Cleaning Wastes from Equipment and Tank Cleaning (T)*

Wastewater Treatment Sludge (T)**

Emission Control Dust/Sludge (T)

I. SUMMARY OF BASIS FOR LISTING

The main source of hazardous wastes generated by the paint manufacturing industry is from the cleaning of mixing tanks and filling equipment. Floor and spill cleanup, cleanout of raw material supply tank cars and trucks, wastewater treatment and air pollution control are additional sources of hazardous waste.

The Administrator has determined that these wastes are solid wastes which may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and, therefore, should be subject to

*The spent caustic and its associated solids may also be corrosive due to the high pH of the caustic cleaning solution. At the present time, however, the Agency has insufficient data to substantiate listing this waste for this characteristic. Therefore, it will be the responsibility of individual manufacturers to determine whether the waste also exhibits this characteristic.

**In addition to being toxic, the wastewater treatment sludge may also be corrosive when caustic is used for tank cleaning and the caustic wash water (which may be corrosive) flows to the wastewater treatment plant. Since available data indicates that the sludge will be corrosive in only a few instances, the Agency is leaving it up to the individual generators to determine whether their waste also exhibits this characteristic.

appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1. The four solid waste streams listed above are deemed toxic because each contains high concentrations of organic and/or inorganic contaminants. Specific contaminants contained in each waste may be summarized as follows:

   - Solvent cleaning wastes - lead and chromium

   - Water and/or caustic cleaning waste - lead, mercury, benzene, carbon tetrachloride, methylene chloride, tetrachloroethylene, naphthalene, di-(2-ethylhexyl)phthalate, di-n-butylphthalate and toluene.

   - Wastewater treatment sludges - chromium, lead, mercury, nickel, methylene chloride, and toluene.

   - Emission control dust/sludge - antimony, cadmium, chromium, lead, nickel, silver, cyanides, phenol, mercury, pentachlorophenol, vinyl chloride, 3,3-dichlorobenzidene, naphthalene, di(2-ethylhexyl) phthalate, di-N-butyl phthalate, benzene, toluene, carbon tetrachloride, methylene chloride and trichloroethylene.

2. In addition, solvent cleaning wastes are deemed hazardous because they consist of spent mineral spirits which are ignitable as defined by 40 CFR Part 261.21.

3. Present management of these wastes may be inadequate to prevent the toxic constituents in these wastes from migrating to groundwater and nearby surface waters.

4. The various physical forms of these wastes (e.g., liquid form, sludges, and dust of fine particulate composition) could allow the release of the hazardous constituents from their disposal environments. Exposure to an acidic environment could also encourage the solubilizing of the heavy metals

in the wastes (many plants are located in regions known to be subject to acid rainfall), subsequently increasing their concentrations in leachate. Many of the constituents of concern are also volatile and pose an inhalation hazard to persons coming in contact with the waste.

5. The transportation of these wastes to off-site facilities increases the possibility of exposure of these wastes to humans and the environment, should mismanagement occur.

6. Approximately 590,000 tons per year of hazardous wastes are generated by an estimated 1,500 paint manufacturing facilities. Such large quantities of wastes containing high concentrations of hazardous constituents increases the probability of damage to human health and the environment under improper disposal conditions.

7. These paint wastes have been mismanaged in the past, causing potential substantial hazard to human health and the environment.

II. INDUSTRY PROFILE AND MANUFACTURING PROCESS

Overall, the paint industry consists of an estimated 1,500 manufacturing plants. Table 1 presents an approximate breakdown of paint plants by state (1). Paint products manufactured at these sites fall into two general categories: solvent-thinned or water-thinned products. These products are also referred to as solvent-base or water-base formulations. Relatively few plants produce exclusively solvent-base or water-base paints (about 5.1 percent and 4.8 percent respectively). Common practice for paint plants is to manufacture both solvent and water-thinnned products.

TABLE 1

GEOGRAPHICAL DISTRIBUTION OF PAINT PLANTS[1]

EPA Region I		EPA Region II		EPA Region III	
Connecticut	10	New Jersey	112	Delaware	3
Maine	3	New York	109	D.C.	0
Massachusetts	54	Puerto Rico	6	Maryland	20
New Hampshire	3	Virgin Islands	0	Pennsylvania	66
Rhode Island	5			Virginia	13
Vermont	2			West Virginia	4
Total	77		227		106

EPA Region IV		EPA Region V		EPA Region VI	
Alabama	12	Illinois	106	Arkansas	7
Florida	69	Indiana	34	Louisiana	15
Georgia	35	Michigan	47	New Mexico	3
Kentucky	22	Minnesota	19	Oklahoma	9
Mississippi	5	Ohio	103	Texas	58
North Carolina	20	Wisconsin	34		
South Carolina	5				
Tennessee	17				
Total	185		343		92

EPA Region VII	
Iowa	13
Kansas	10
Missouri	51
Nebraska	2
	76

EPA Region VIII	
Colorado	11
Montana	3
North Dakota	0
Utah	4
Wyoming	1
	20

EPA Region IX	
Arizona	6
California	196
Hawaii	0
Nevada	1
	203

EPA Region X	
Alaska	1
Idaho	2
Oregon	20
Washington	22
Total	45

Figures 1 and 2 illustrate typical solvent-base and water-base paint manufacturing operations. Virtually all paint is made in batches. For solvent-base paints (see Figure 1), the mixing and grinding of raw materials (pigments, oils, solvents and resins) is accomplished in one production step. For high gloss paints, the pigments and a portion of the binder and vehicle are mixed into a paste of a specified consistency. This paste is fed to a grinder, which disperses the pigments by breaking down particle aggregates rather than by reducing the particle size. Two types of grinders are ordinarily used for this purpose: pebble or steel ball mills, or roll-type mills. Other paints are mixed and dispersed in a mixer using a saw-toothed dispersing blade, which is commonly referred to as a high speed disperser.

In the next stage of production, the paint is transferred to tinting and thinning tanks, occasionally by means of portable transfer tanks, but more commonly by gravity feed or pumping. Here, the remaining binder and liquid, as well as various additives and tinting colors, are incorporated. The finished product is then transferred to a filling operation where it is filtered, packaged and labeled.

Water-base paints are produced in a slightly different manner from solvent-base paints (see Figure 2). The pigments and extending agents are usually received in proper particle size, and the dispersion of the pigment, surfactant and binder into the vehicle is accomplished with a saw-toothed

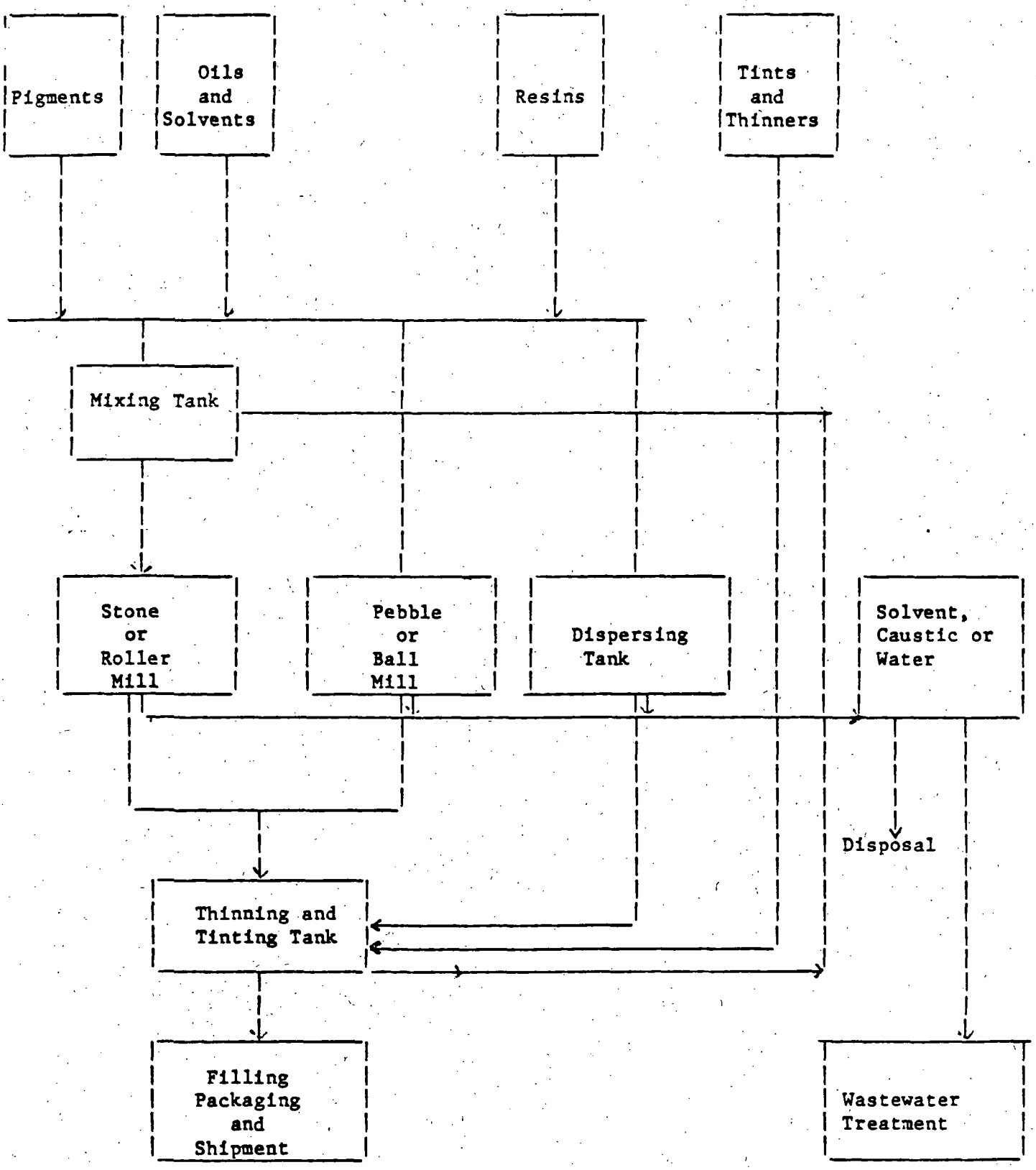
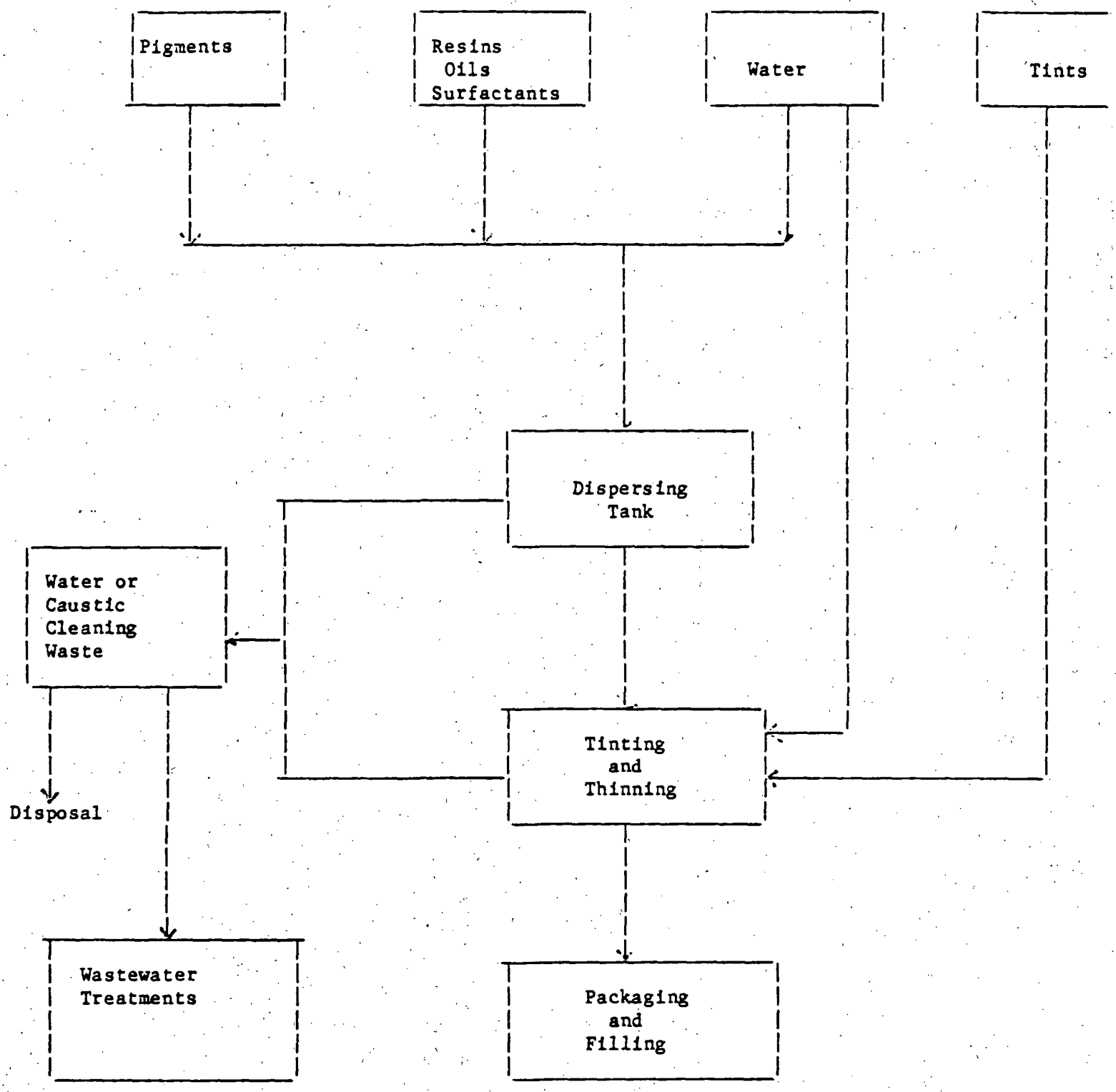


Figure 1 - Flow Diagram of Manufacturing Process for Solvent Base Paints



'igure 2 - Flow Diagram of Manufacturing Process for Water-Base Paints

high speed disperser. In small plants, the paint is thinned and tinted in the same tank, while in larger plants, the paint may be transferred to special tanks for the final thinning and tinting. Once the formulation is correct, the paint is transferred to a filling operation where it is filtered, packaged and labeled in the same manner as solvent-base paints.

III. GENERATION AND MANAGMENT OF LISTED WASTE STREAMS (1,2)

The four hazardous waste streams of concern are generated primarily as a result of the clean-up of tanks and other equipment. Table 2 summarizes the hazardous waste generation rates in the paint manufacturing industry.

Three specific methods of paint tank cleaning are commonly used in the Paint Industry. These cleaning methods include (1) solvent wash, (2) caustic wash and (3) water wash. Solvent wash is used exclusively for cleaning tanks used for solvent-based paint formulation. Caustic wash techniques may be used to clean solvent-base and water-base paint manufacturing tanks. Water washing techniques are also used in both the solvent-based and water-based segments of the Paint Industry. For solvent-base operations, water washing is usually used only to follow caustic washing of solvent-based tanks. For water-base operations, water washes often constitute the only tank cleaning operation. Periodic caustic cleaning of water-base paint tanks is also a common practice.

TABLE 2

HAZARDOUS WASTE GENERATION RATES

IN THE PAINT MANUFACTURING INDUSTRY (1,2)

Waste	Tons Per Year
Wastewater and Caustic Rinse Water	520,000(a)
Wastewater Treatment Sludge	39,200(b)
Solvent Cleaning Wastes (not reclaimed)	29,000
Air Pollution Control Residues	1,700
TOTAL	589,900

(a) Wash water and spent caustic that is disposed untreated as of June, 1980.

(b) Includes 42 plants that currently treat wash water and spent caustic generating 15 percent sludge, by volume.

1. Solvent Cleaning Wastes: Solvent-base paint mixing tanks and other accessory equipment are cleaned with either solvent (primarily mineral spirits), caustic or a combination of the two. The used solvent is normally handled in one of three ways: (1) used in the next compatible batch of product as part of the formulation; (2) collected and redistilled either by the plant or an outside company; or (3) reused with or without settling until it loses its cleaning ability, or is "spent". When spent, the waste solvent is drummed and removed for disposal. If solids are settled out of the used solvent, the resultant sludge is also drummed and removed for disposal. The category "solvent cleaning wastes" thus includes both spent solvent and solids contained in the spent solvent. Sometimes the two are disposed of separately--i.e. the solids are settled out of the spent solvent and disposed of as a sludge, in which case both are deemed hazardous.

Approximately 29,000 tons of solvent cleaning wastes (not reclaimed) are generated per year.(2)

2. Water and/or Caustic Cleaning Wastes: Tanks and equipment used to manufacture water-based paint are generally washed with water. Rinse water is usually handled in one of four ways: (1) used in the next compatible batch of paint as part of the formulation; (2) discharged with or without treatment as wastewater; (3) removed for off-site disposal; or (4) reused either with or without treatment

to clean tanks and equipment until spent. If sludge is settled out of the spent rinse water, it is disposed of as a solid waste.

Caustic (NaOH) is used to clean tanks and equipment used in the manufacture of both solvent and water based paints. Most plants using caustic reuse the solution until it loses some of its cleaning ability. At that time, it is disposed of as either a solid waste or wastewater with or without neutralization of other treatment. Following caustic cleaning, tanks and equipment are usually rinsed with water. This wastewater is handled in one of three ways: (1) recycled to the caustic solution as make-up water; (2) drummed for disposal as a solid waste; (3) discharged as wastewater with or without pretreatment--sometimes first combined with other plant wastewater prior to treatment or disposal. Caustic cleaning techniques can also create a sludge when a recirculating caustic system is employed. The sludge is comprised of paint solids which often accumulate at the bottom of the caustic reservoir and must periodically be removed when caustic make-up is required.

The category "water and/or caustic cleaning wastes" thus includes spent rinse water, spent caustic, and any solids associated with wastes generated by water cleaning and caustic cleaning of equipment and tanks. Sometimes the two phases are disposed of separately--the solids are settled out of the spent rinse water and/or caustic

wash and disposed of as sludges, in which case both phases are included in this listing. Approximately 520,000 tons per year of wastewater and caustic rinse water are currently generated per year.

3. Wastewater Treatment Sludges are generated by the paint industry primarily by the physical/chemical treatment of equipment and tank rinsewater, caustic cleaning waste, and other miscellaneous wastewater streams generated at various parts of the plant.

The sludge produced from wastewater treatment is generally 15 precent by volume of the plant wastewater quantity (1). Proposed pretreatment standards may eliminate the generation of these wastewater treatment sludges (1). Instead, 20% of the wastewater generated may be hauled to disposal sites. This could result in up to 156,000 tons of wastewater being hauled to disposal sites annually.

4. Emission Control Dust/Sludge: Air pollution control devices are usually applied to plant ventilation exhausts to prevent outside air contamination. The purpose of in-plant ventilation is to remove airborne dusts and solvent fumes that pose either a health hazard to workers or create an explosive atmosphere. The residues from the control dusts consist of dust and particulate matter collected in filter systems which are usually associated with emptying bags into process mixers (2). Some plants

use a wet emission control system, in which case a sludge (rather than dust) is generated. (Small plants do not normally employ emission control equipment.[2]) Approximately 1,700 tons of air pollution control residues are generated per year.[2]

Disposal Practices

Treated and untreated wastewaters (water and/or caustic cleaning wastes) are discharged to POTWs or placed in drums for disposal in landfills.[1] About 19.7 percent of all paint plants engage contract haulers to remove paint wastewater.[1] Table 3 summarizes the major wastewater disposal methods used in the paint industry. As shown by the table, discharge to POTWs is the most frequently used disposal method.

The 29,000 tons per year of unreclaimed solvent are disposed primarily in landfills[2] in 55-gallon drums. Still bottoms from solvent reclaiming operations are also sealed in drums and disposed of in landfills.[1]

Sludges generated during physical/chemical wastewater treatment processes are disposed of in one of two general ways--by contract hauling and by landfill. At least one large paint producer stores paint wastewater treatment sludge in an on-site impoundment.[1] Most contract haulers dispose of the sludge in landfills, although a small number incinerate or reclaim it (1). Approximately 19% of all paint plants do not know what the contract hauler does with the waste.[1]

Emission control dusts/sludges are generally disposed of by contract hauling.[2]

IV. HAZARDOUS PROPERTIES OF THE WASTE

A. Waste Composition

In general, the EPA has designated the wastes generated by water and/or caustic or solvent rinsing of paint manufacturing equipment as hazardous wastes because they are contaminated with toxic chemicals found in paint. The products and raw materials of the paint industry have been shown to contain at least 21 organic and inorganic priority pollutants[1] (see Table 4). Since the purpose of these cleaning operations is to remove unusable paint product, these contaminants necessarily will be found in the various cleaning wastes. The sludges resulting from settling of these wastes are also expected to contain some of these toxic constituents, as are the wastewater treatment sludges and air pollution control dusts/sludges. The specific constituents and hazards associated with each listed waste are described in greater detail below. The health and environmental hazards associated with the specific constituents in the listed wastes are described on pp. 33-57 and in Appendix A.

TABLE 3

WASTEWATER DISPOSAL METHODS (1)

Disposal Method	All Plants	
	Number of Plants*	Percent of Total
Complete Reuse	88	6.4
Partial Reuse	262	19.1
Evaporation	125	9.1
Discharge to City Sewer	475	34.6
Discharge to Storm Sewer	68	4.9
Discharge to Receiving Stream	13	0.9
Impoundment on Plant Property	87	6.3
Incineration	5	0.4
Contract Hauling	271	19.7
Landfilled	107	7.8
Well or Septic Tank	13	0.9
Spray Irrigation	8	0.6

*Some plants indicated multiple disposal methods.

TABLE 4

TOXIC CONSTITUENTS IN RAW MATERIALS
USED BY THE PAINT INDUSTRY(1)

Priority Pollutant	Responders Indicating Usage of Raw Materials Containing Specific Priority Pollutants*			
	Minimum		Maximum	
	No. of plants	Percent	No. of Plants	Percent
Antimony	166	12.1	243	17.7
Cadmium	260	18.9	312	22.7
Chromium	1042	75.8	1083	78.8
Lead	833	60.6	1016	73.9
Nickel	156	11.4	395	28.7
Silver	250	18.2	440	32.0
Cyanides	860	62.6	1064	77.4
Phenol	665	48.4	765	55.7
Mercury	627	45.6	627	45.6
Pentachlorophenol	190	13.8	190	13.8
Vinyl Chloride	550	40.0	563	41.0
3,3-Dichlorobenzidene	409	29.8	412	30.0
Naphthalene	772	61.6	772	56.2
Di-(2 Ethylhexyl)Phthalate	338	24.6	338	24.6
Di-N-Butyl Phthalate	354	25.8	354	25.8
Benzene	66	4.8	66	4.8
T uene	961	69.9	998	72.6
C bon Tetrachloride	8	0.6	8	0.6
1,1,1 Trichloroethane	140	10.2	140	10.2
Methylene Chloride	305	22.2	305	22.2
Trichloroethylene	77	5.6	77	5.6

(*) Data generated from 1374 responses to paint industry "308" survey. Since many of the raw materials included in the 308 Data Collection Portfolio can contain more than one toxic pollutant, the Agency was unable to obtain unambiguous counts for the occurence of particular toxic pollutants. A conservative approach was taken because of this. When the Data Collection Portfolio response did not indicate clearly which toxic pollutant was in use, the Agency made two counts - one including neither, one including both. This gave a maximum and minimum count for toxic pollutants.

Solvent Cleaning Wastes

Solvent cleaning wastes are considered hazardous because they have been documented to contain significant concentrations the two toxic heavy metals lead and chromium. In addition to posing a toxicity hazard, the solvent cleaning waste is also considered hazardous because the solvents employed in the cleaning process, primarily mineral spirits, are ignitable. The flash point of mineral spirits is 104°F (4) and therefore meets the §261.21 characteristic of ignitability (i.e. <140°F for liquids). The following data from state manifests illustrates both the significant heavy metal concentrations in these wastes, and the fact that the wastes' flashpoint meets the criteria for ignitability (5,6):

1. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

Waste Name: Still bottoms and thinner sludge

Quantity: 120,000 gallons (liquid)

Percent Analysis: 68.2% Solvents

31.8% Pigments and Resins

Chemical Analysis:

Metal	Total Concentration (ppm)
Cr	27.6
Pb	112.9

Flashpoint: 70°F

2. State: Illinois

Source: Special Waste Disposal Applications, Illinois EPA

Waste Name: Paint Sludges

Quality: 458,000 gallons

Percent Analysis: 53% Solvents

45% Pigment and Binder

2% Inorganic Residue

Flashpoint: 110°F

Chemical Analysis:

Metal	Total Concentration (ppm)
Cr	166
Pb	1203

3. State: New Jersey

Source: Industrial Waste Surveys, New Jersey Department of Environmental Conservation

Waste Name: Dirty Wash Solvent

Quantity: 37,000 gallons/year (liquid)

Percent Analysis: 85% Solvents

10% Resins

5% Pigments

Chemical Analysis:

Contaminant	Total Concentrations (ppm)
Chromates	7000
Lead	3000

Waste Properties: Flammable, Toxic (reported by generator)

In summary, solvent cleaning wastes are being listed as hazardous because (1) the solvents used to clean tanks and equipment are ignitable; and (2) the solvent cleaning wastes have been documented as containing the toxic compounds lead and chromium, in significant concentrations.

Water and/or Caustic Cleaning Wastes

The Administrator has classified water and/or caustic cleaning wastes as hazardous because of the levels of ten toxic constituents found in samples of the waste. Table 6 summarizes data which substantiate EPA's listing of these wastes as hazardous. These data were selected from EPA's Development Document for Effluent Limitations Guidelines and Standards for the Paint Formulating Point Source Category.[1] (Note that "untreated wastewater" samples are representative of water and/or caustic cleaning wastes before treatment.) These data indicate that lead, mercury, benzene, carbon tetrachloride, methylene chloride, tetrachloroethylene, naphthalene, di(2-ethylhexyl) phthalate (DEHP), di-n-butyl-phthalate and toluene are typically found in water and/or caustic cleaning wastes. Concentrations of these toxic pollutants in the wastewaters exceed 10 or even 100 times the existing drinking water or ambient water quality standards.

Wastewater Treatment Sludge

The Administrator has classified wastewater treatment sludges from paint manufacturing as hazardous because of the levels of six toxic constituents found in samples of the waste. EPA tested samples of this waste from several plants and found that it contained inorganic and organic priority pollutants.[1] The data shown in Table 7 from EPA's Development for Effluent Limitations Guidelines and Standards for the Paint Formulating Point Source Category

TABLE 6

UNTREATED WASTEWATER* DATA -- SELECTED POLLUTANTS

1977/1978 SAMPLING PROGRAM (1)

HAZARDOUS CONSTITUENT	--- NUMBER OF --- SAMPLES ANALYZED	TIMES ABOVE DET. LIMIT	AVERAGE (mg/l)	MEDIAN (mg/l)	MINIMUM (mg/l)	MAXIMUM (mg/l)	MASS LOADING (KG/YEAR)**
Lead	60	45	6.300	.805	.022	80.000	4,475
Mercury	55	44	5.161	.500	.001	62.000	3,650
Benzene	31	18	1.933	.370	.020	9.900	800
Carbon tetrachloride	31	7	3.770	.014	<.010	30.000	675
Methylene chloride	31	17	31.878	.620	<.010	210.000	13,100
Tetrachloroethylene	31	16	.567	.175	<.010	4.900	232.5
Naphthalene	31	8	2.950	.054	<.010	18.000	600
Di (2-Ethylhexyl) Phthalate	31	9	.418	.140	<.010	2.810	105
Di-N-Butyl-Phthalate	31	13	5.745	.160	<.010	69.000	2,475
Toluene	31	27	17.966	2.500	.073	259.700	11,075

* Representative of water and/or caustic cleaning wastes before treatment.

**Assumes production 250 days per year.

TABLE 7

WASTEWATER TREATMENT SLUDGE DATA SUMMARY

1977/1978 SAMPLING PROGRAM (1)

HAZARDOUS CONSTITUENT	-----Number of-------- SAMPLES ANALYZED	TIMES ABOVE DET. LIMIT	AVERAGE (MG/L)	MEDIAN (MG/L)	MINIMUM (MG/L)	MAXIMUM (MG/L)	MASS LOADING (KG/YEAR)*
Chromium	39	37	7.050	.700	<.50	90.000	767.5
Lead	39	37	10.770	3.000	<.100	80.000	1065
Mercury	36	31	15.061	.640	.005	220.000	1687.5
Nickel	39	27	10.443	.200	.020	200.000	1132.5
Methylene chloride	9	8	120.201	1.735	.300	900.000	12,764.25
Toluene	9	8	44.740	.905	.130	350.00	4650

*Assumes production 250 days/year

indicate that chromium, lead, mercury, nickel, methylene chloride and toluene, are typically found in wastewater treatment sludge from paint manufacturing.

In addition to the EPA data, the following data from Illinois and New Jersey[5,6] indicate that wastewater treatment sludge from paint manufacturing contains elevated levels of chromium in both cases, and lead in one case. Further, an acid leaching test performed on one of the samples indicates that the chromium and lead can, in fact, be extracted at levels which exceed 10 and 100 times (respectively) the drinking water standards for these metals.[5,6]

1. State: Illinois

   Source: Special Waste Disposal Applications, Illinois EPA

   Waste Name: Paint Sludge

   Quantity: 50,000 gallons

   Percent Analysis: 50% Resins

   45% Pigments

   <1% Xylol, toluol, isopropyl alcohol

Chemical Analysis:	Metal	Concentration in Waste (ppm)	Concentrations in Leachate (ppm)
	Cr^{+6}	1500	1.3
	Pb	9200	5.4

2. State: New Jersey

Source: Industrial Waste Surveys, New Jersey Department of Environmental Protection

Waste Name: Emulsion Paint Sludge

Quantity: 70,000 gallons/year (sludge)

Percent Anaysis: 60% Water

20% TiO2

20% Latex Solids

Chemical Analysis:	Metal	Concentration in Waste (ppm)
	Pb	300

Waste Properties: Irritant, toxic (reported by generator)

Emission Control Dusts/Sludges

The Administrator has classified emission control dusts/sludges as hazardous because the Agency has reason to believe that these wastes contain substantial quantities of the toxic raw materials used in the formulation of paint products (see Section III, Generation and Management of Listed Waste Streams), and therefore that the wastes pose a substantial threat to human health and the environment. Specifically, this waste is being listed as a hazardous waste because of the presence of the following toxic constituents which are constituents of raw materials used in paint manufacturing:

antimony
cadmium
chromium
lead
nickel
silver
cyanides
phenol
mercury
pentachlorophenol
vinyl chloride
3,3'-dichlorobenzidene
naphthalene
di(2-ethylhexyl) phthalate
di-N-Butyl phthalate
benzene
toluene
carbon tetrachloride
1,1,1-trichloroethane
methylene chloride
trichloroethylene

If emission control residues are collected wet, scrubber water is often diverted to the wastewater treatment plant for treatment before disposal. In this case, the scrubber water becomes a source of the wastewater treatment sludge, which has already been demonstrated as being hazardous.

B. Potential for Substantial Hazard from Improper Waste Management

As shown above, these wastes contain a wide range of toxic organic and inorganis constituents, in many cases in significant concentrations. Many of these constituents, namely benzene, hexavalent chromium, carbon tetrachloride, tetrachloroethylene, 3,3'-Dichlorobenzidine, and trichloroethylene have been identified by the Agency's Carcinogen

Assessment Group as possessing substantial evidence of carcinogenicity, increasing Agency concerns as to the potential of these wastes to cause substantial harm if mismanaged. Under these circumstances, the Agency requires assurance that waste constituents will not migrate and persist should mismanagement occur.

Such assurance does not appear possible here since most waste constituents appear quite capable of migration in substantial concentrations, and of mobility and persistence upon environmental release. As shown in Table 8, most of the organic compounds in these wastes are very water soluble, and some (such as phenol) extremely so. The heavy metals are likewise known to be capable of migrations in leachate. These compounds thus present a danger of migration via a groundwater pathway if exposed to a leaching medium.

Other compounds, particularly benzene, vinyl chloride, toluene, trichloroethylene, 1,1,1'-trichloroethane, and methylene chloride, are significantly volatile and could pose an inhalation hazard to environmental receptors in the vicinity of improperly disposed wastes.

These constituents are likewise capable of mobility and persistence upon environmental release. Many constituents have in fact been involved in damage incidents resulting from improper waste management, empirically demonstrating mobility and persistence of waste constituents. For example,

Table 8*

Compound	Vapor Pressure (mm Hg)	Solubility in Water
Antimony	Varies, depending on which salt of of the metal is present in the waste.	
Cadmium		
Chromium		
Lead		
Nickel		
Silver		
Cyanides		
Mercury		
Phenol	0.2mm at 20°C[8]	82 g/l at 15°C[8]
Pentachlorophenol	.00011mm at 20°C[8]	14 mg/l at 20°C[8]
Vinyl Chloride	2,660mm at 25°C[8]	1.100 mg/l at 25°C[8]
3,3'-Dichlorobenzidene	low	4 mg/l[11]
Naphthalene	1mm at 53°C[8]	30 mg/l[8]
Di-2-Ethylhexylphthalate	1.2mm at 200°C[8]	50 mg/l[9]
Di-n-Butylphthalate	0.1mm at 115°C[8]	400 mg/l at 28°C[8]
Toluene	28.4 at 25°C[8]	470 mg/l at 25°C[8]
Benzene	76mm at 20°C[8]	1,780 mg/l at 20°C[8]
Trichloroethylene	77 at 25°C[7]	1,000 mg/l at 20°C[7]
1,1,1-trichloroethane	100 at 20°C	950 mg/l at 25°C
Methylene Chloride	350 at 20°C	20,000 mg/l at 25°C[7]
Tetrachloroethylene	19 at 25°C[7]	150 mg/l at 25°C[7]

*Table compiled from data given in "Physical/Chemical Properties of Hazardous Waste Constituents" (U.S. EPA, 1980) unless otherwise specified by superscript.

trichloroethylene, benzene, vinyl chloride, methylene chloride, and tetrachloroethylene were all involved in the contamination of drinking water sources in New Hanover, North Carolina. (Muskie report) Toluene and benzene are among the constituents present in water and air samples taken in the Love Canal area. ("Love Canal Public Health Bomb", a Special Report to the Governor and Legislature, New State Department of Health (1978)). Trichloroethylene and phenol were involved in a damage incident in Sehigh Co., Pa. where industrial wastes contaminated drinking water wells. (Muskie) Heavy metals and cyanides likewise have been involved in numerous damage incidents from improper waste disposal. (Muskie) Pentachlorophenol has been detected in surface water and finished drinking waster (Appendix B), and is only moderately degradable. (Id.)

The remaining compounds likewise appear capable of mobility and persistence. The two phathalate esters present are mobile (particularly in soils low in organic content), and are capable of persistence in most environments, although subject to biodegradation. Both esters are also bioaccumulative, so that exposure to small concentrations may still prove dangerous.(11)

3,3'-dichlorobenzidene has limited mobility in clay, or in soils high in organic content (11), but could be mobile in other media. Photolysis is the most significant degradation mechanism (11), and so would not effect this compound's persistence in groundwater.

Napthalene is likewise capable of migration through soils (11), and since it is not subject to hydrolysis (although it is biodegradable) (11), could persist in the abiotic conditions of most aquifers. These constituents thus have the capacity for migration, mobility and persistence, raising the possibility of potential hazard if the wastes are mismanaged.

Additionally, present management and disposal practices (see Section III) for these hazardous wastes may be inadequate to protect human health and the environment from exposure to the toxic constituents shown to be present in the wastes. Landfilling of any of the listed wastes in unsecure landfills could contaminate underlying groundwater or nearby surface water as the waste releases toxic constituents.

In particular, landfilling of liquid wastes such as the water and/or caustic cleaning waste, solvent cleaning waste, or a sludge which has not been dewatered, may pose a threat to water supplies because many of the toxic constituents present in the liquid waste are already solubilized in the liquid and would tend to pass more quickly through a landfill, even without the percolating action of rainwater on the landfill. The state manifest information presented above indicates that some of these toxic constituents will indeed be released from the waste. These wastes thus could contaminate drinking water supplies and pose a threat to human health and the environment through ingestion of water contaminated with the toxic constituents of concern.

Dewatered sludges--wastewater treatment sludges or air pollution (emission) control sludges--also pose a threat to human health and the environment if mismanaged. Extraction data have shown that the wastewater treatment sludges sometimes leach contaminants in excess of ten times the drinking water standard for chromium and lead. These data indicate that the sludges contain chromium and lead in a soluble form and thus could be released in harmful concentrations.

In general, if these wastes should be exposed to an acid environment, for example, disposed in landfills containing organic refuse or disposed in areas subject to acid rainfall, these constituents' concentrations in leachate would be similar to concentrations shown by the leaching data from the state manifests. As indicated in Table 1, many of these plants are located in regions known to be subject to acid rainfall (east of the Mississippi).

The dry air pollution (emission) control residue could pose an additional hazard. These emission control dusts are of a fine particulate composition, and therefore a large surface area is exposed to leaching action of any percolating medium. Dusts can pose a hazard in addition to that of ground and surface water contamination. Airborne exposure to, for instance, lead and chromium compounds escaping from air pollution control dusts poses an inhalation

hazard. These minute particles could be dispersed by the wind if waste dusts are piled in the open, placed in unsecure landfills or improperly handled during transportation. As a result, the health of persons who inhale the airborne particles would be jeopardized.

A further consideration in the regulation of these hazardous wastes is that they are transported to off-site disposal facilities. This increases the likelihood of their being mismanaged, i.e., uncontrolled transportation may result either in their not being properly handled during transport or their not reaching their destination at all. A transportation and manifest system combined with designated standards for the management of these wastes will greatly reduce their availability to harm to humans and the environment. In fact, many generators of these wastes actually indicated that at the present time they are ignorant of the ultimate disposition of the wastes they give to contract haulers (see pp. 14-15 above). In fact, in a recent damage incident, a number of 55 gallon drums of paint sludge were haphazardly dumped on a house farm north of Richmond, Virginia. These drums were traced back to a Maryland paint company. (Washington Post, June 23, 1980, at B 1.) The danger of improper transport of these wastes thus appears very high.

These wastes are generated in very substantial quantities (See Table 2) and contain significant concentrations of the

toxic constituents of concern (see previously sited data). Large amounts of these contaminants pose the danger of polluting large areas of ground and surface waters near an unsecure landfill. Contamination could also occur for any long periods of time, since large amounts of pollutants are available for environmental loading. Attenuative capacity of the environment surrounding an inadequate disposal facility could also be reduced or used up due to the large quantities of pollutants available. All of these considerations increase the possibility of exposure to the harmful constituents in the wastes.

V. Health and Environmental Effects (10)

The following contaminants of paint wastes are designated as priority pollutants under Section 307(a) of the Clean Water Act:

antimony
cadmium
chromium
lead
mercury
nickel
silver
cyanides
phenol
pentachlorophenol
vinyl chloride
3,3-dichlorobenzidene
benzene
carbon tetrachloride
methylene chloride
tetrachloroethylene
naphthalene
di (2-ethylhexyl) phthalate
di-N-butyl-phthalate
toluene
trichloroethylene

Lead is also regulated under the Clean Air Act. Proposed or final standards have been issued for most of these chemicals under the Occupational Safety and Health Act of 1970. More specific information on the health effects of these chemicals are summarized below. For further information on the health effects of all of these constituents, see Appendix A.

Antimony

Essentially no information on antimony-induced human health effects has been derived from community epidemiology studies. The available data are in literature relating effects observed with therapeutic or medicinal uses of antimony compounds and industrial exposure studies. Large therapeutic doses of antimonial compounds, usually used to treat schistisomiasis, have caused severe nausea, vomiting, convulsions, irregular heart action, liver damage, and skin rashes. Studies of acute industrial antimony poisoning have revealed loss of appetite, diarrhea, headache, and dizziness in addition to the symptoms found in studies of therapeutic doses of antimony.

For the protection of human health from toxic properties of antimony ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.145 mg/l.

Antimony compounds remaining in wastewater treatment sludge under anaerobic conditions may be connected to stibine (SbH_3), a very soluble and very toxic compound. Antimony is not known to be essential to the growth of plants, and has been reported to be moderately toxic. Therefore, sludge containing large amounts of antimony could be detrimental to plants if it is applied in large amounts to cropland.

Cadmium

Cadmium is an extremely dangerous cumulative toxicant (the metal is not excreted), causing progressive chronic poisoning in mammals, fish, and probably other organisms.

Toxic effects of cadmium on man have been reported from throughout the world. Cadmium may be a factor in the development of such human pathological conditions as kidney disease, testicular tumors, hypertension, arteriosclerosis, growth inhibition, chronic disease of old age, and cancer. Cadmium is normally ingested by humans through food and water as well as by breathing air contaminated by cadmium dust. Cadmium is cumulative in the liver, kidney, pancreas, and thyroid of humans and other animals. A severe bone and kidney syndrome known as itai-itai disease has been documented in Japan as caused by cadmium ingestion via drinking water and contaminated irrigation water. Ingestion of as little as 0.6 mg/day has produced this disease. Cadmium acts syn-

ergistically with other metals. Copper and zinc substantially increase its toxicity.

Cadmium is concentrated by marine organisms, particularly molluscs, which accumulate cadmium in calcareous tissues and in the visera. A concentration factor of 1,000 for cadmium in fish muscle has been reported, as have concentration factors of 3000 in marine plants and up to 29,600 in certain marine animals. The eggs and larvae of fish are apparently more sensitive than adult fish to poisoning by cadmium, and crustaceans appear to be more sensitive than fish eggs and larvae.

For the protection of human health from the toxic properties of cadmium ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.010 mg/l.

Data show that cadmium can be incorporated into crops, including vegetables and grains, from contaminated soils. Two Federal agencies have already recognized the potential adverse human health effects posed by the use of sludge on cropland. The FDA recommends that sludge containing over 30 mg/kg of cadmium should not be used on agricultural land. Sewage sludge contains 3 to 300 mg/kg (dry basis) of cadmium; mean = 10 mg/kg; median = 16 mg/kg. The USDA also recommends placing limits on the total cadmium from sludge that may be applied to land.

Chromium

The two chromium forms most frequently found in industry wastewaters are hexavalent and trivalent chromium. Some of it is reduced to trivalent chromium as part of the process reaction. The raw wastewater containing both valence states is usually treated first to reduce remaining hexavalent to trivalent chromium, and second to precipitate the trivalent form as the hydroxide. The hexavalent form is not removed by lime treatment.

Chromium, in its various valence states, is hazardous to man. It can produce lung tumors when inhaled, and induces skin sensitizations. Large doses of chromates have corrosive effects on the intestinal tract and can cause inflammation of the kidneys. Hexavalent chromium has been identified by the Agency's Carcinogen Assessment Group as exhibiting substantial evidence of being carcinogenic. Levels of chromate ions that show no effect in man appear to be so low as to prohibit determination, to date.

The toxicity of chromium salts to fish and other aquatic life varies widely with the species, temperature, pH, valence of the chromium, and synergistic or antagonistic effects, especially the effect of water hardness. Studies have shown that trivalent chromium is more toxic to fish of some types than is hexavalent chromium. Hexavalent chromium retards growth of one fish species at 0.0002 mg/l. Fish food organisms and other lower forms of aquatic life are extremely

sensitive to chromium. Therefore, both hexavalent and trivalent chromium must be considered harmful to particular fish or organisms.

For the protection of human health from the toxic properties of chromium (except hexavalent chromium) ingested through water and contaminated aquatic organisms, the recommended water quality criterion is 0.050 mg/l. For the maximum protection of human health from the potential carcinogenic effects of exposure to hexavalent chromium through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero.

Chromium is not destroyed when treated by wastewater treatment (although the oxidation state may change), and will either pass through to the wastewater treatment effluent or be incorporated into the wastewater treatment sludge. Both oxidation states can cause wastewater treatment inhibition and can also limit the usefulness of municipal sludge.

Chromium not passed through a wastewater treatment plant will be retained in the sludge, where it is likely to build up in concentration. Disposal of sludges containing very high concentrations of trivalent chromium can potentially cause problems in secure landfills. Incineration, or similar destructive oxidation processes can produce hexavalent chromium from lower valence states. Hexavalent chromium is potentially more toxic than trivalent chromium. In cases where high rates of chrome sludge application on land are used, distinct growth inhibition and plant tissue uptake have been noted.

Lead

Lead ingested by humans produces a variety of toxic effects including impaired reproduction ability, disturbances in blood chemistry, neurological disorders, kidney damage, and adverse cardiovascular effects. Exposure to lead in the diet results in permanent increase in lead levels in the body. Most of the lead entering the body eventually becomes localized in the bones where it accumulates. Lead is a carcinogen or cocarcinogen in some species of experimental animals. Lead is teratogenic in experimental animals. Mutagenicity data are not available for lead.

For the protection of human health from the toxic properties of lead ingested through water and through contaminated aquatic organisms the ambient water criterion is 0.050 mg/l.

Mercury

Mercury can be introduced into the body through the skin and the respiratory system as the elemental vapor. Mercuric salts are highly toxic to humans and can be absorbed through the gastrointestinal tract. Fatal doses can vary from 1 to 30 grams. Chronic toxicity of methyl mercury is evidenced primarily by neurological symptoms. Some mercuric salts cause death by kidney failure.

Mercuric salts are extremely toxic to fish and other aquatic life. Mercuric chloride is more lethal than copper, hexavalent chromium, zinc, nickel and lead towards fish and aquatic life. In the food cycle, algae containing mercury up

to 100 times the concentration in the surrounding sea water are eaten by fish which further concentrate the mercury. Predators that eat the fish in turn concentrate the mercury even further.

For the protection of human health from the toxic properties of mercury ingested through water and through contaminated aquatic organisms the ambient water criterion is determined to be 0.0002 mg/l.

In sludges, mercury content may be high if industrial sources of mercury contamination are present. Little is known about the form in which mercury occurs in sludge. Mercury may undergo biological methylation in sediments, but no methylation has been observed in soils, mud, or sewage sludge.

The mercury content of soils not receiving additions of POTW sewage sludge lie in the range from 0.01 to 0.5 mg/kg. In soils receiving POTW sludges for protracted periods, the concentration of mercury has been observed to approach 1.0 mg/kg. In the soil, mercury enters into reactions with the exchange complex of clay and organic fractions, forming both ionic and covalent bonds. Chemical and microbiological degradation of mercurials can take place side by side in the soil, and the products - ionic or molecular - are retained by organic matter and clay or may be volatilized if gaseous. Because of the high affinity between mercury and the solid soil surfaces, mercury persists in the upper layer of soil.

Mercury can enter plants through the roots, it can readily move to other parts of the plant, and it has been reported to

cause injury to plants. In many plants mercury concentrations range from 0.01 to 0.20 mg/kg, but when plants are supplied with high levels of mercury, these concentrations can exceed 0.5 mg/kg. Bioconcentration occurs in animals ingesting mercury in food.

Nickel

The toxicity of nickel to man is thought to be very low, and systemic poisoning of human beings by nickel or nickel salts is almost unknown. In non-human mammals nickel acts to inhibit insulin release, depress growth, and reduce cholesterol. A high incidence of cancer of the lung and nose has been reported in humans engaged in the refining of nickel.

Nickel salts can kill fish at very low concentrations. However, nickel has been found to be less toxic to some fish than copper, zinc, and iron. Nickel is present in coastal and open ocean water at concentrations in the range of 0.0001 to 0.006 mg/l although the most common values are 0.002 - 0.003 mg/l. Marine animals contain up to 0.4 mg/l and marine plants contain up to 3 mg/l. Higher nickel concentrations have been reported to cause reduction in photosynthetic activity of the giant kelp. A low concentration was found to kill oyster eggs.

For the protection of human health based on the toxic properties of nickel ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.133 mg/l.

Nickel toxicity may develop in plants from application of

sewage sludge on acid soils. Nickel has caused reduction of yields for a variety of crops including oats, mustard, turnips, and cabbage. In one study nickel decreased the yields of oats significantly at 100 mg/kg.

Whether nickel exerts a toxic effect on plants depends on several soil factors, the amount of nickel applied, and the contents of other metals in the sludge. Unlike copper and zinc, which are more available from inorganic sources than from sludge, nickel uptake by plants seems to be promoted by the presence of the organic matter in sludge. Soil treatments such as liming reduce the solubility of nickel. Toxicity of nickel to plants is enhanced in acidic soils.

Silver

Metallic silver is not considered to be toxic, but most of it salts are toxic to a large number of organisms. Upon ingestion by humans, many silver salts are absorbed in the circulatory system and deposited in various body tissues, resulting in generalized or sometimes localized gray pigmentation of the skin and mucous membranes know as argyria. There is no known method for removing silver from the tissues once it is deposited, and the effect is cumulative.

Silver is recognized as a bactericide and doses from 0.000001 to 0.0005 mg/l have been reported as sufficient to sterilize water. The criterion for ambient water to protect

human health from the toxic properties of silver ingested through water and through contaminated aquatic orgnisms is 0.010 mg/l.

The chronic toxic effects of silver on the aquatic environment have not been given as much attention as many other heavy metals. Data from existing literature support the fact that silver is nearly the most toxic of the heavy metals, there are insufficient data to adequately evaluate even the effects of hardness on silver toxicity. There are no data available on the toxicity of different forms of silver.

Cyanides

Cyanides are among the most toxic of pollutants commonly observed in industrial wastewaters. Introduction of cyanide into industrial processes is usually by dissolution of potassium cyanie (KCN) or sodium cyanide (NaCN) in process waters. However, hydrogen cyanide (HCN) formed when the above salts are dissolved in water, is probably the most acutely lethal compound.

The relationship of pH to hydrogen cyanide formation is very important. As pH is lowered to below 7, more than 99 percent of the cyanide is present as HCN and less than 1 percent as cyanide ions. Thus, at neutral pH, that of most living organisms, the more toxic form of cyanide prevails.

Cyanide ions combine with numerous heavy metal ions to form complexes. The complexes are in equilibrium with

HCN. Thus, the stability of the metal-cyanide complex and the pH determine the concentration of HCN. Stability of the metal-cyanide anion complexes is extremely variable. Those formed with zinc, copper, and cadmium are not stable--they rapidly dissociate, with production of HCN, in near neutral or acid waters. Some of the complexes are extremely stable. Cobaltocyanide is very resistant to acid distillation in the laboratory. Iron cyanide complexes are also stable, but undergo photodecomposition to give HCN upon exposure to sunlight. Synergistic effects have been demonstrated for the metal cyanide complexes making zinc, copper, and cadmium, cyanides more toxic than an equal concentration of sodium cyanide.

The toxic mechanism of cyanide is essentially an inhibition of oxygen metabolism, i.e., rendering the tissues incapable of exchanging oxygen. The cyanogen compounds are true noncumulative protoplasmic poisons. They arrest the activity of all forms of animal life. Cyanide shows a very specific type of toxic action. It inhibits the cytochrome oxidase system. This system is the one which facilitates electron transfer from reduced metabolites to molecular oxygen. The human body can convert cyanide to a non-toxic thiocyanate and eliminiate it. However, if the quantity of cyanide ingested is too great at one time, the inhibition of oxygen utilization proves fatal before the detoxifying reaction reduces the cyanide concentration to a safe level.

Cyanides are more toxic to fish than to lower forms of aquatic organisms such as midge larvae, crustaceans, and mussels. Toxicity to fish is a function of chemical form and concentration, and is influenced by the rate of metabolism (temperature), the level of dissolved oxygen, and pH. In laboratory studies free cyanide concentrations ranging from 0.05 to 0.15 mg/l have been proven to be fatal to sensitive fish species including trout, bluegill, and fathead minnows. Levels above 0.2 mg/l are rapidly fatal to most fish species. Long term sublethal concentrations of cyanide as low as 0.01 mg/l have been shown to affect the ability of fish to function normally, e.g., reproduce, grow, and swim.

For the protection of human health from the toxic properties of cyanide ingested through water and throguh contaminated aquatic organisms, the ambient water quality criterion is determined to be 0.200 mg/l.

Phenol

Phenol exhibits acute and sub-acute toxicity in humans and laboratory animals. Acute oral doses of phenol in humans cause sudden collapse and unconsciousness by its action on the central nervous system. Death occurs by respiratory arrest. Sub-acute oral doses in mammals are rapidly absorbed then quickly distributed to various organs, then cleared from the body by urinary excretion and metabolism. Long term exposure by drinking phenol contaminated water has resulted in statistically significant increase in

reported cases of diarrhea, mouth sores, and burning of the mouth. In laboratory animals long term oral administration at low levels produced slight liver and kidney damage. No reports were found regarding carcinogenicity of phenol administered orally - all carcinogenicity studies were skin tests.

For the protection of human health from phenol ingested through water and through contaminated aquatic organisms the concentration in water should not exceed 3.4 mg/l.

Fish and other aquatic organisms demonstrated a wide range of sensitivities to phenol concentration. However, acute toxicity values were at moderate levels when compared to other organic priority pollutants.

Pentachlorophenol

Although data are available on the human toxicity effects of pentachlorophenol, interpretation of data is frequently accompanied by exposure to other wood preservatives. Additionally, experimental results and occupational exposure observations must be examined carefully to make sure that observed effects are produced by the pentachlorophenol itself and not by the by-products which usually contaminate pentachlorophenol.

Acute and chronic toxic effects of pentachlorophenol in humans are similar: muscle weakness, headache, loss of appetite, abdominal pain, weight loss, and irritation of skin, eyes, and respiratory tract. Available literature

indicates that pentachlorophenol does not accumulate in body tissues to any significant extent. Studies on laboratory animals of distribution of the compound in body tissues showed the highest levels of pentachlorophenol in liver, kidney, and intestine, while the lowest levels were in brain, fat, muscle, and bone.

Toxic effects of pentachlorophenol in aquatic organisms are much greater at pH of 6 where the ionic form predominates. Similar results were observed in mammals where oral lethal doses of pentachlorophenol were lower when the compound was administered in hydrocarbon solvents (un-ionized form) than when it was administered as the sodium salt (ionized form) in water.

For the protection of human health from the toxic properties of pentachlorophenol ingested through water and through contaminated aquatic organisms, the ambient quality criterion is determined to be 0.140 mg/l.

Vinyl Chloride

Vinyl chloride is a well-known human and animal carcinogen. Several occupational epidemiology studies in highly exposed workers have reported excess rates of liver angiosarcoma and tumors at other organ sites. Animal experiments using both inhalation and oral routes of exposure have also induced liver angiosarcoma. Because there is no recognized safe concentration for a human carcinogen, the

recommended concentration of vinyl chloride in water for maximum protection of human health is zero.

Because of its high vapor pressure vinyl chloride volatilizes rapidly from the aquatic environment. Because it is so readily volatilized, it does not undergo bioaccumulation except under extreme exposure conditions. Existing evidence indicates that it is resistant to microbial degradation.

3,3'-dichlorobenzidene

DCB has been shown to be a carcinogen in non-human mammals under controlled laboratory conditions. Exposure to DCB results in various types of sarcomas and adenocarcinomas. Tumors have been induced both locally (at the site of injection) and remotely (multi-system involvement after feeding). Experiments shown DCB to be a much less potent carcinogen in animals than the unsubstituted base (benzidene). U.S. EPA's Carcinogen Assessment Group (CAG) has evaluated 3,3'-dichlorobenzidine and has found sufficient evidence to indicate that this compound is carcinogenic. DCB was found to be acutely toxic to bluegill sunfish at levels of 0.5 mg/l or greater in the water.(12)

There are few data available on the bioconcentration, bioaccumulation, and biomagnification of DCB in the aquatic environment. DCB has been shown to be experimentally bioconcentrated by fish to a significant degree -- approximately 1150 fold. However, no DCB was detected in fish sampled from the vicinity of a DCB contaminated waste lagoon using analytical methods with sensitivities of 10 to 100 mg/kg.

Benzene

The chronic, rather than acute toxicity of benzene is important in industry. It is a recognized carcinogen of the blood-forming tissues. The exposure routes of concern are ingestion, inhalation and skin absorption through repeated exposures.

Benzene is harmful to human health according to numerous published studies. Most studies relate effects of inhaled benzene vapors. These effects include nausea, loss of muscle coordiantion, and excitement, followed by depression and coma. Death is usually the result of respiratory or cardiac failure. Two specific blood disorders are related to benzene exposure. One of these, acute myelogenous leukemia, represents a carcinogenic effect of benzene.

Oral administration of benzene to laboratory animals produced leukopenia, a reduction in number of leukocytes in the blood. Subcutaneous injection of benzene-oil solutions

has produced suggestive, but not conclusive, evidence of benzene carcinogenisis.

Benzene demonstrated teratogenic effects in laboratory animals, and mutagenic effects in humans and other animals.

For maximum protection of human health from the potential carcinogenic effects of exposure to benzene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of benzene estimated to result in additional lifetime cancer risk at levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00015 mg/l, 0.0015 mg/l, and 0.015 mg/l, respectively.

Carbon Tetrachloride

Carbon tetrachloride produces a variety of toxic effects in humans. Ingestion of relatively large quantities - greater than five grams - has frequently proved fatal. Symptoms are burning sensation in the mouth, esophagus and stomach, followed by abdominal pains, nausea, diarrhea, dizziness, abnormal pulse, and coma. When death does not occur immediately, liver and kidney damage are usually found. Symptoms of chronic poisoning are not as well defined. General fatigue, headache, and anxiety have been observed, accompanied by digestive tract and kidney discomfort or pain.

Data concerning teratagenicity and mutagenicity of carbon tetrachloride are scarce and inconclusive. However, carbon tetrachloride has been demonstrated to be carcinogenic in laboratory animals. The liver was the target organ.

For the maximum protection of human health from the potential carcinogenic effects of exposure to carbon tetrachloride through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of carbon tetrachloride estimated to result in additional lifetime cancer risk at risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.000026 mg/l, 0.00026 mg/l, and 0.0026, respectively.

Methylene Chloride

Methylene chloride is highly toxic by the inhalation route of exposure over a short period of time.

Inhaled methylene chloride acts as a central nervous nervous depressant. There is also evidence that the compound causes heart failure when large amounts are inhaled.

Methylene chloride does produce mutation in tests for this effect. In addition a bioassay recognized for its extremely high sensitivity to strong and weak carcinogens produced results which were marginally significant. Thus potential carcinogenic effects of methylene chloride are not confirmed or denied, but are under continuous study. Difficulty in conducting and interpreting the test results from the low boiling point (40°C) of methylene chloride which increases the difficulty of maintaining the compound in growth media during incubation at 37°C; and from the difficulty of removing all impurities, some of which might themselves be carcinogenic.

For the protection of human health from the toxic properties of methylene chloride ingested through water and contaminated aquatic organisms, the ambient water criterion is 0.002 mg/l.

Trichloroethylene

Data on the effects produced by ingested TCE are limited. Most studies have been directed at inhalation exposure. Nervous system disorders and liver damage are frequent results of inhalation exposure. In the short term exposures, TCE acts as a central nervous system depressant - it was used as an anesthetic before its other long term effects were defined.

TCE has been shown to induce transformation in a highly sensitive *in vitro* Fischer rat embryo cell system (F1706) that is used for identifying carcinogens. Severe and persistant toxicity to the the liver was recently demonstrated when TCE was shown to produce carcinoma of the liver in mouse strain B6C3F1. One systematic study of TCE exposure and the incidence of human cancer was based on 518 men exposed to TCE. The authors of that study concluded that although the cancer risk to man cannot be ruled out, exposure to low levels of TCE probably does not present a very serious and general cancer hazard.

TCE is bioconcentrated in aquatic species, making the consumption of such species by humans a significant source of TCE. For the protection of human health from the potential carcinogenic effects of exposure to trichloroethylene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of trichloroethylene estimated to result in additional lifetime cancer risk of 1 in 100,000 corresponds to an ambient water concentration of 0.00021 mg/l.

Only a very limited amount of data on the effects of TCE on freshwater aquatic life are available. One species of fish (fathead minnows) showed a loss of equilibrium at concentrations below those resulting in lethal effects.

Tetrachloroethylene

Tetrachloroethylene is highly toxic via ingestion and moderately toxic via inhalation and skin absorption as well as being carcinogenic.

The prinicipal toxic effect of tetrachloroethylene on humans is central nervous system depression when the compound is inhaled. Headache, fatigue, sleepiness, dizziness and sensations of intoxication are reported. Severity of effects increases with vapor concentration. High integrated exposure (concentration times duration) produces kidney and liver damage. Very limited data on tetrachloroethylene ingested by laboratory animals indicate liver damage occurs

when PCE is administered by that route. Tetrachloroethylene tends to distribute to fat in mammalian bodies.

One report found in the literature suggests, but does not conclude, that tetrachloroethylene is teratogenic. Tetrachloroethylene has been demonstrated to be a liver carcinogen in B6C3-F1 mice.

For the maximum protection of human health from the potential carcinogenic effects of exposure to tetrachloroethylene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of tetrachloroethylene estimated to result in additional lifetime cancer risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.000020 mg/l, 0.00020 mg/l, and 0-.0020 mg/l, respectively.

Naphthalene

Naphthalene, ingested by humans, has reportedly caused vision loss (cataracts), hemolytic anemia, and occasionally, renal disease. These effects of naphthalene ingestion are confirmed by studies on laboratory animals. No carcinogenicity studies are available which can be used to demonstrate carcinogenic activity for naphthalene. Naphthalene does bioconcentrate in aquatic organisms.

For the protection of human health from the toxic properties of naphthalene ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 143 mg/l.

Only a limited number of studies have been conducted to determine the effects of naphthalene on aquatic organisms. The data from those studies show only moderate toxicity.

Di (2-ethylhexyl) phthalate

Di (2-ethylhexyl) phthalate is insoluble in water. For the protection of human health from the toxic properties of di(2-ethylhexyl) phthalate ingested through water and through contaminated aquatic organisms, the ambient water quality criterion is determined to be 10 mg/l.

Di-n-butyl phthalate

The water solubility of di-n-butyl phthalate at room temperature is reported to be 0.4 g/l and 4.5 g/l in two different chemistry handbooks.

For protection of human health from the toxic properties of di-n-butyl phthalate ingested through water and through contaminated aquatic organisms, the ambient water quality criterion is determined to be 5 mg/l.

Toluene

Toluene is moderately toxic by ingestion and inhalation. Because toluene is both water soluble and volatile, it may pose a threat to human health by both exposure routes, respectively. Toluene is volatile (vapor pressure of toluene is 36.7 mm at 30°C); handling and disposal of the waste may thus pose an inhalation hazard. If the waste is disposed in an unsecured landfill the toluene may be solubilized from the waste (the

water solubility of toluene is 535 mg/l, and it is miscible with a variety of organic solvents) by rainfall and contaminate underlying potable groundwater sources with may pose a hazard to human health when the water is ingested.

Most data on the effects of toluene in human and other mammals have been based on inhalation exposure or dermal contact studies. There appear to be no reports of oral administration of toluene on human subjects. A long term toxicity study on female rats revealed no adverse effects on growth, mortality, appearance and behavior, organ to body weight ratios, blood-urea nitrogen level, bone marrow counts, peripheral blood counts, or morphology of major organs. The effects of inhaled toluene on the central nervous system, both at high and low concentrations, have been studied in humans and animals. However, ingested toluene is expected to be handled differently by the body because it is absorbed more slowly and must first pass through the liver before reaching the nervous system. Toluene is extensively and rapidly metabolized in the liver. One of the principal metabolic products of toluene is benzoic acid, which itself seems to have little potential to produce tissue injury.

Toluene has been found in fish caught in harbor waters in the vicinity of petroleum and petrochemical plants. Bioconcentration studies have not been conducted, but bioconcentration factors have been calculated on the basis of the octanol-water partition coefficient.

For the protection of human health from the toxic properties of toluene ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 12.4 mg/l.

1,1,1-Trichloroethane

Most human toxicity data for 1,1,1-trichloroethane relates to inhalation and dermal exposure routes. Limited data are available for determining toxicity of ingested 1,1,1-trichloroethane, and those data are all for the compound itself not solutions in water. No data are available regarding its toxicity to fish and aquatic organisms. For the protection of human health from the toxic properties of 1,1,1-trichloroethane ingested through the consumption of water and fish, the ambient water criterion is 15.7 mg/l. The criterion is based on bioassy for possibly carcinogenicity.

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Response to Comments to the Proposed Rule

Two commenters responding to the proposed Hazardous Waste Guidelines and Regulations (43 FR 58946, December 18, 1978) objected to the classification of paint wastes, stating that EPA had been "overly broad" in its classification (5). Dupont commented that the diversity of products, product types, and different chemical formulations makes the listing of paint wastes (specifically "water-based paint wastes") impossible without a detailed listing of the waste generated by the manufacture of various paint products.

Based on the information presented in this document, the Agency believes these listed wastes are typically or frequently hazardous. Individual generators can, of course, petition to delist their waste. In further reponse, EPA cites information considered by Effluent Guidelines Division for subcategorization of the paint industry (1):

> EPA considered the following factors in determining whether differences within the paint industry might require separate limitations:
>
> 1. Raw materials and products
> 2. Production Methods
> 3. Size and age of production facilities
> 4. Wastewater characteristics
> 5. Tank cleaning techniques.

The Agency concluded that tank cleaning techniques offer appropriate basis for subcategorization; examination of the other four factors proved to be inappropriate for subcategori-

zation. (See Reference 1, pp. 53-55).

A second comment was that wastewater treatment sludge from latex paint production is not hazardous because extracts of the waste do not exceed 10 times the drinking water standards. National Paint and Coatings Association submitted extraction data on seven samples of latex sludge using the TEP ("Toxicant Extraction Procedure"--an extraction test which was a pre-proposal version of the EP). Test results show heavy metals in the extract to be less than 100 times the drinking water standard for those metals.

As far as differentiating latex paint wastewater treatment sludge from other wastewater treatment sludge in the industry, EPA cannot do so because 1) only 4.8% of paint manufacturers produce exclusively water-based paint and 2) when evaluating factor #4 listed above, EPA found that no specific segment of the industry has a significantly different quality or quantity of wastewater, and therefore concludes the same for the wastewater treatment sludge. In addition, EPA is listing wastewater treatment sludge for factors other than EP toxicity, including levels of heavy metals in the sludge, total quantities of the waste produced and disposed per year, and, perhaps most significantly the presence of toxic organics in the sludge.

Organic Chemicals

LISTING BACKGROUND DOCUMENT

NITROBENZENE/ANILINE PRODUCTION

Distillation Bottoms from Aniline Production (T)

Combined Wastewater Streams Generated from Nitrobenzene/ Aniline Production (T)*

Process Residues from Aniline Extraction (T)*

I. Summary of Basis for Listing

The first listed waste is the distillation bottom residue from the purification of aniline by distillation. The second listed waste is the combined process wastewater streams from the co-production of nitrobenzene and aniline. These waste streams contain toxic nitrogenous organic materials, and the wastewater stream is likely to contain benzene as well. The third listed waste stream results from the extraction step in aniline production, and may or may not be combined with other process waters. This listing covers the uncombined waste streams.

The Administrator has determined that still bottoms from aniline distillation, process residues from aniline extraction (when generated as a separate waste stream and not combined with other process wastewater streams), and wastewater generated from nitrobenzene and aniline production are solid wastes which may pose a substantial present or potential hazard to

*These waste streams were not included in the initial listing, and are initially proposed in the present document.

human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1) The distillation bottoms contain aniline, diphenylamine, nitrobenzene, and phenylenediamine while the combined wastewater stream contains these constituents and usually contains benzene as well.* The process residues from aniline extraction, if disposed of separately, contains aniline, nitrobenzene and phenylenediamine. All of these constituents are toxic. Benzene is a known human carcinogen. Aniline, diphenylamine and phenylenediamine are carcinogenic to laboratory animals. Diphenylamine is expected to bioaccumulate.

2) Current disposal practices of these wastes are not well documented. However, there is a high potential for contaminating groundwater by leaching from waste treatment lagoons or landfills that are not properly designed or operated, since these constituents have high migratory potential, and some have proven mobile and persistent in actual waste management practice. In addition, under certain conditions, release to the atmosphere by volatilization poses a risk of inhalation of aniline and nitrobenzene.

3) In a damage incident involving improperly managed aniline distillation bottoms, waste oils were contaminated with nitrobenzene from the distillation residues and spread over roads, posing the risk of human exposure to dangerously high concentrations of nitrobenzene. This waste has thus proven capable of posing a potential substantial hazard in actual waste management practice.

4) The State of Texas regulates distillation bottoms from aniline production as a hazardous waste.

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* Aniline, diphenylamine and phenylenediamine are not presently listed in Appendix VIII to Part 261. An amendment to Appendix VIII to add these constituents is being prepared concurrently with this listing document.

5) Total potential loadings of benzene and aniline in the wastewater stream from the production of nitrobenzene and aniline could be as high as 9.5 kkg and 150 kkg annually, quantities believed by the Agency to be quite significant in view of these compounds' adverse health effects.

II. Sources of the Waste and Typical Disposal Practices

A. Profile of the Industry

Nitrobenzene and aniline are major chemical intermediates; the actual nameplate capacity was reported as 557,000 kkg[25] and 313,000 kkg respectively.[2] The U.S. International Trade Commission lists aniline as the sixth largest volume intermediate in terms of 1978 production.[1] Table 1 lists the facilities producing nitrobenzene and aniline, and their production capacities. As is indicated, most facilities produce both nitrobenzene and aniline. In fact, 97% of nitrobenzene produced is used for the synthesis of aniline. The balance is purified for use chiefly as a solvent, or in the manufacture of pharmaceuticals, dyes and photographic chemicals.

United States production of aniline is increasing. Production levels were 151,000 kkg in 1969, 186,000 kkg in 1972, 187,000 kkg in 1975,[3] and 270,000 kkg in 1978.[1] Aniline production capacity is anticipated to reach 450,000 kkg in 1980. Most aniline (about 40%) is used for the production of methylene diisocyanate, an intermediate used in the manufacture of urethanes; another 35% is used in the

Table 1

PRODUCER LOCATIONS AND PRODUCTION CAPACITIES

MANUFACTURER	FACILITY	PRODUCTION CAPACITY (10^3kkg) 1978 Nitrobenzene[25]	1977 Aniline[2]
American Cyanamid Co.	Bound Brook, NJ	48	27
American Cyanamid Co.	Willow Island	33	28
E. I. Dupont de Nemours & Company, Inc.	Beaumont, TX	140	104
E. I. Dupont de Nemours & Company, Inc.	Gibbstown, NJ	90	59
First Mississippi Corp.	Pascaqoula, MS	151	45
Mallinkrodt Corp.	Raleigh, NC	0	10
Mobay Chemical Corp.	New Martinsville, WV	61	45
Rubicon Chemicals, Inc.	Geismar, LA	34	27
		557	340

synthesis of rubber chemicals.[2] The remainder is mainly used in the manufacture of dyes and drugs.

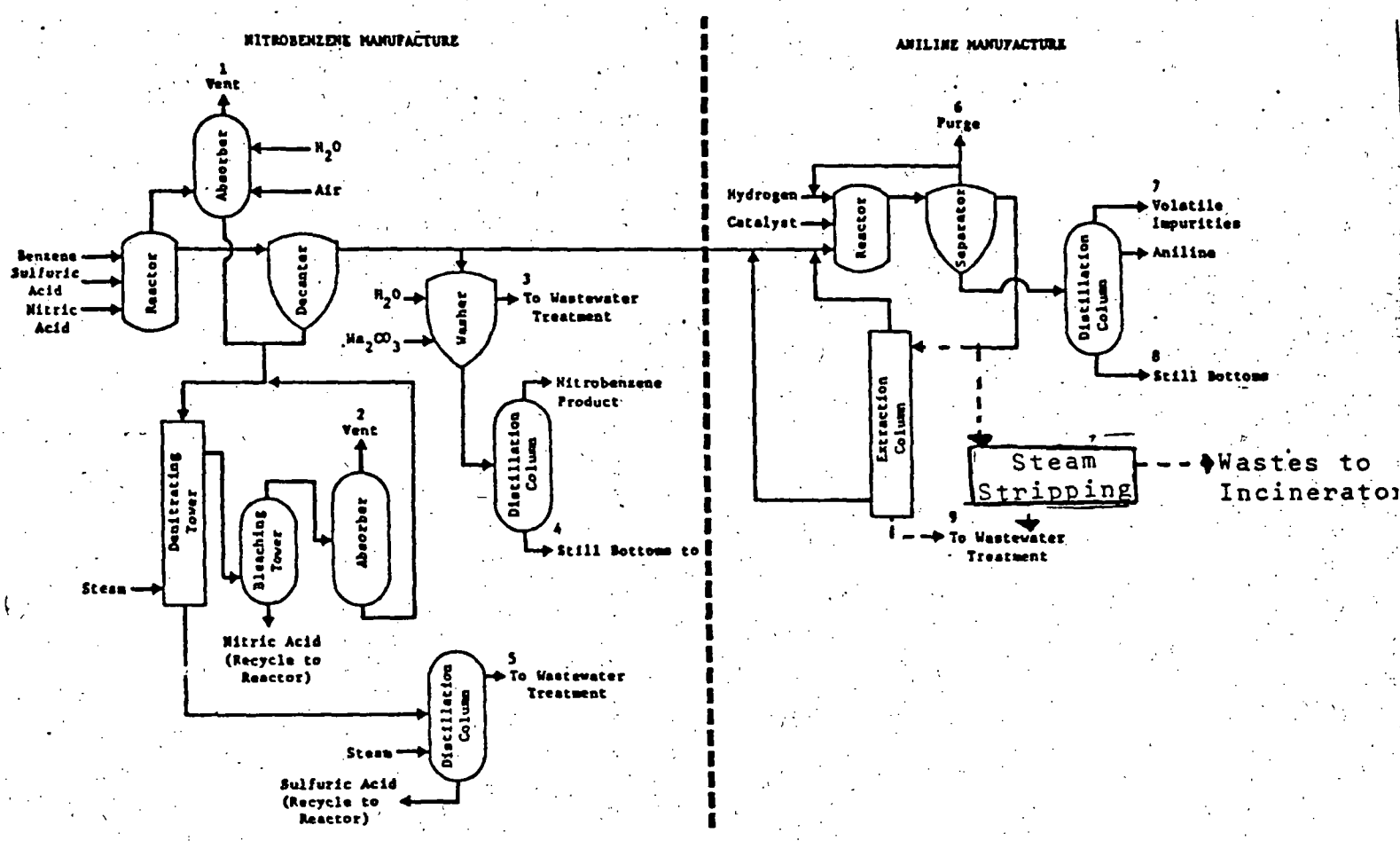
B. Manufacturing Process[2]

1. Manufacture of Nitrobenzene

Nitrobenzene is made by the direct nitration of benzene using a sulfuric-nitric acid mixture. In the most common continuous phase process, benzene is nitrated with an aqueous mixture of sulfuric acid (53 to 60 mole percent) and nitric acid (39 to 32 mole percent) at atmospheric pressure and temperatures between 45 to 90°C. Yields are typically better than 98 percent. This process (see Figure 1) is carried out in vented stainless steel vessels equipped with high speed agitators and cooling coils. Average residence time is approximately 8 to 10 minutes. Nitrobenzene is continuously drawn from the side of the reactor and separated in a decanter. Once separated, this "crude" nitrobenzene is reportedly used directly in the manufacture of aniline.

If pure nitrobenzene is required, the product is washed first with water and subsequently with an alkaline solution (generally either a sodium carbonate or sodium hydroxide solution) in small vessels equipped with high speed mechanical agitators, and then distilled. The wastewater resulting from the washing operation (stream 3 in Figure 1), is one component of the waterborne waste stream of concern in this document.

FIGURE 1
SIGNIFICANT POLLUTANTS FROM
NITROBENZENE/ANILINE MANUFACTURE (MODIFIED FROM (2))



Point 1*
Benzene, Nitroalkanes, Nitrobenzene, Nitrogen Oxides

Point 2*
Benzene, Nitroalkanes, Nitrobenzene, Nitrogen Oxides

Point 3
Benzene, Benzoic Acid, Carboxylic Acids, Nitrates, Nitrites, Nitrobenzene, Nitrophenol

Point 4**
Dinitrobenzene, Nitrobenzene, Nitrophenol, Nitrogen Containing High Molecular Weight Polymers, Polycarboxylic Acid, Dinitrotoluene

FIGURE 1 CONTINUED

Point 5
Benzene, Nitrobenzene, Nitrophenol, Polycarboxylic Acid, Nitrogen Containing High Molecular Weight Polymers

Point 6*
Aniline, Carbon Monoxide, Hydrogen, Methene, Nitrobenzene

Point 7*
Cyclohexylamine, Volatile Amines, Water

Point 8*
Aminophenols, Azepins; Diphenylamine, Nitrobenzene, Phenylenediamine, Nitrogen Containing High Molecular Weight Polymers

Point 9
Aminophenol, Aniline, Nitrobenzene, Phenylenediamine, Water Soluble Amines

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* Emitted to air and therefore not subject to RCRA.
**This waste was listed in the May 19, 1980 promulgation (see "Nitrobenzene Background Document" for details).

Figure 1 to be inserted here.

Recovery of spent acid (A in Figure 1), is essential from the standpoint of economical operation. Generally, unreacted nitric acid is extracted from the spent acid by steam stripping (denitrating tower). The bottom product, dilute sulfuric acid (60 percent by weight), is then concentrated by distillation (sulfuric acid concentrator) and recycled to the reactor as shown, or used in other manufacturing operations. Nitric acid removed overhead from the denitrating tower is bleached with air to remove nitrogen oxide and subsequently recycled to the reactor. The overhead nitrogen oxides from the bleacher are scrubbed with water and recycled to the denitrating tower.* The waste resulting from acid recovery (number 5 in Figure 1) is another component of the aqueous waste stream of concern in this document.

2. Production of Aniline[2,3]

In the U.S., aniline production is based almost exclusively on vapor phase reduction of nitrobenzene in the presence of a copper catalyst. This process is also illustrated in Figure 1. With the exception of one facility (Mallinkrodt, Inc.), the nitrobenzene feedstock is produced on site.[2] The nitrobenzene is vaporized in a stream of hydrogen and introduced into the reactor. The crude product mixture (aniline, hydrogen and water) leaving the reactor is condensed and separated from

*Another approach to spent acid recovery uses benzene, rather than steam, to strip nitric acid from spent acid in the denitrating tower. The nitric acid is thus dissolved in the benzene and fed to the reactor. The remaining sulfuric acid is concentrated as before.

the gas stream. Most of this gas stream is compressed and recycled to the reactor, but, to prevent build-up of gaseous impurities in the reactor, some gas is purged. The two-phase (aqueous and organic) reactor product mixture is separated. The lower organic phase (stream B, Figure 1), consisting principally of aniline, up to 5 percent nitrobenzene, and 5 percent water,[2] is purified by two stage distillation. In the crude still, aniline and water are removed overhead, while higher boiling organic impurities, such as nitrobenzene, remain in the still bottoms (noted as 8, Figure 1). In a finishing distillation step, the overhead product from the crude still is purified to 99% specification, and the bottoms from this finishing distillation step are combined with the crude distillation bottoms. (This process is shown as a single distillation in Figure 1.)[3]

Several methods are used to recover aniline from the aqueous phase of the separator (C in Figure 1). Aniline may for instance be concentrated from this stream by steam stripping. The resulting enriched aniline/water mixture is then incinerated. This latter waste stream is not included within the present listing, although it may be listed in the future. The Agency solicits information as to the composition of this waste and risks associated with its improper disposal.

At some facilities aniline is recovered by countercurrent extraction with nitrobenzene. Recovered aniline and nitrobenzene are recycled to the reactor. In either case (i.e., if either

extraction or steam stripping is used), the residual waste stream (9 in Figure 1) ordinarily is directed to wastewater treatment with other process wastewater streams. This is the third component of the waterborne waste stream of concern in this document. In some facilities, the residues from the extraction step are not combined with other process wastewaters. In such cases, the listing includes the separate wastewater stream from the extraction step.

C. Waste Generation and Management

The listed wastes consist of still bottoms from the distillation of aniline (Point 8, Figure 1) and the wastewater streams generated from nitrobenzene/aniline manufacture (points 3, 5 and 9 of Figure 1), which are most often combined before wastewater treatment. (Wastes from the aniline extraction step are listed when disposed of separately, as discussed above.)

On the basis of process chemistry assumptions set forth in (2), the aniline distillation bottoms are expected to contain nitrobenzene, aniline, diphenylamine, and phenylenediamine. While precise concentrations are unknown, concentrations of nitrobenzene are expected to be quite high, since the organic phase prior to distillation consists of 5 percent nitrobenzene, most of which would be expected to be (and is intended to be) removed by distillation. A damage incident involving this waste (described at pp. 14-15 below) likewise suggests that nitrobenzene concentrations may be quite substantial.

The volume of aniline still bottoms and the present practices of the industry with regard to their disposal are not well defined. The most common disposal method for distillation bottoms is storage in drums in private landfills.[27] Some of these wastes are apparently utilized for their acid-neutralizing capacity in drilling operations.[4]

The wastewater stream components from nitrobenzene/aniline manufacture include: the nitrobenzene washwater (Point 3), the acid distillation column overhead (point 5) and the aniline recovery stream (point 9). Based on a knowledge of process chemistry, these streams are estimated to contain the pollutants indicated in Figure 1. Most manufacturers combine these waste lines prior to treatment.[2] Table 2 lists typical concentrations of selected pollutants found in combined nitrobenzene/aniline waste streams, as reported by two manufacturers.[2]

A variety of wastewater treatment methods are applied, and it is not known to what extent these are successful in removing the toxic chemicals from the listed waste. The following treatment methods have been reported:[2] steam stripping, carbon adsorption, aerated lagoon, biological contact, clarification, equalization, activated sludge, stabilization pond, land application, and subsurface disposal.

As noted above, the waste waters from the extraction step of aniline production are not always combined with other process wastewater streams. When disposed of separately,

Table 2

Characterization of Raw Waste Loading From Nitrobenzene/Aniline Manufacture[2]

	kg/kkg aniline product			kkg/yr*
	Avg.	Min.	Max.	Max.
Aniline	0.067	0.005	0.49	150
Benzene	0.005	0	0.031	9.5
Nitrobenzene	0.002	0	0.012	3.7

In addition to the above pollutants whose identity was quantitatively confirmed, animophenol, benzoic acid, nitrophenol, and phenylene diamine as well as nitrates and nitrites are estimated[2] to occur. Of these constituents the wastewater loading data show that at least aniline, benzene and nitrobenzene are present in substantial concentrations, and generated in significant quantities annually.

*Obtained by multiplying the maximal value by the 340,000 kkg by 90% of annual aniline nameplate production capacity (since plants rarely operate at 100% of capacity).

this waste stream is expected to contain aniline, phenylenediamine and nitrobenzene as constituents of concern.[2]

III. Discussion of Basis for Listing

A. Hazards Posed by the Waste

On the basis of available information, it is apparent that the listed wastes contain toxic organic materials, including nitrobenzene, aniline, diphenylamine and phenylenediamine, and (for the combined wastewaters) benzene. These constituents are all toxic, and all but nitrobenzene are experimental or (in the case of benzene) known carcinogens. All of these constituents are projected to have migratory potential and to be mobile and persistent in ground and surface water (Appendix B), so that they can create a substantial hazard if disposal facilities are not properly designed and operated. Aniline, nitrobenzene and phenylenediamine are quite soluble (solubility 34,000, 38,000 ppm and 1900 ppm respectively),[6] and thus can easily migrate through unsaturated sandy soils. Diphenylamine is also significantly soluble for purposes of risk of chronic exposure (300 ppm (6)). Furthermore, the solubility of amines such as aniline and phenylendiamine increases significantly under conditions which are more acidic than their acid dissociation constant (pKa is 6.0 for phenylenediamine). Since the pH of the rainfall in the United States presently ranges from 4.0 - 5.0[9,22], residues of aniline and phenylenediamine can be expected to

leach to surface and groundwater if these wastes are improperly transported, treated, stored, disposed of, or otherwise managed.

Present waste disposal practices may be inadequate to prevent waste migration. Certainly, improper management may result in release of harmful constituents, particularly in view of the properties of the waste constituents as described above. For instance, if this waste should be exposed to an environment subject to acid rainfall, disposed residues containing phenylenediamine contacted by acid rainfall can be expected to leach and to migrate to surface and groundwater.

Further, if this waste is treated in a lagoon, even under relatively mild environmental conditions, the harmful constituents can be expected to leach from the waste, as a result of their moderate to extreme water solubility properties. Once released from the matrix of the waste, these constituents could migrate from the waste and contaminate groundwater. Nitrobenzene, for example, has proven mobile and persistent in two major damage incidents involving waste disposal at the Monsanto Chemical dump in East St. Louis and at the LaBounty dump in Charles City, Iowa.(10)

Another potential hazard associated with lagoon treatment of this waste would be the volatilization of compounds with appreciable vapor pressure such as benzene into the atmosphere, thus posing a hazard via inhalation. Benzene has proven capable of migration and persistence via an air exposure

pathway in many actual damage incidents, Love Canal being the most notorious.

If the wastes are landfilled, even in plastic-lined drums, they create a potential hazard. All drums have a limited life span, for the exterior metal corrodes in the presence of even small amounts of moisture. When this occurs, the potential for groundwater contamination is high if the landfill is not properly designed or operated. It should be noted that many of the subject production facilities are located in regions of significant rainfall (LA, NJ, WV), so that ample percolating liquid is available for leachate formation. (In any case, there is no reason to believe that wastes will be containerized at all, since, absent Subtitle C regulation, wastes could be landfilled in a variety of improper ways.)

A special hazard posed by these subject wastes is the possibility of the formation over time of highly carcinogenic nitrosamines from some of their constituents.[2] Aniline and other amines (most importantly secondary amines) as well as nitrites are thought to be present in these wastes (Figure 1). These substances may react to form nitrosamines, especially under acidic conditions. Such conditions might result as a consequence of co-disposal of the listed wastes with acidic wastes, or under conditions of continued acid rainfall.

Improperly managed aniline distillation bottoms have been involved in at least one damage incident.[23] From 1976

through November 1978, contaminated waste oils were used as dust suppressants on roads throughout East Texas. The chief source of contamination were aniline tars (still bottoms) from aniline production*, generated by Dupont's Beaumont facility. These still bottoms were sent to Browning-Ferris Industries Chemical Services, Inc., a state permitted waste management facility, which proceeded impermissibly to mix the wastes with waste oil, which oil was used indiscriminately as a road dust supressant. Nitrobenzene levels in contaminated soil varied, and were as high as 21,000 ppm. Most of the concentrations were deemed by state environmental officials as more than sufficient to cause substantial harm. The danger was discovered before occurence of known harm, and Browning-Ferris was ordered to remove approximately 10,000 cubic yards of contaminated material from one subdivision, and additional amounts of material from four additional subdivisions.(23)

This incident not only illustrates the potential for substantial harm if this waste is disposed of improperly, but also suggests strongly that the aniline distillation residues may contain very high concentrations of nitrobenzene, in light of the substantial concentrations found in the contaminated road oil. Furthermore, aniline distillation bottoms are

* The waste oils were heavily contaminated with nitrobenzene, and the only source of nitrobenzene in wastes accepted by Browning-Ferris were aniline distillation wastes. (23 at p. 17.)

regulated as hazardous wastes (termed 'Class I wastes' under the state waste management system) by the State of Texas (23), another indication of their potential for hazard.

B. Health and Ecological Effects of Waste Constituents of Concern

Benzene

Acute exposure to high concentrations of benzene causes central nervous system depression (euphoria, nausea, staggering gait and coma). Inhalation of lower amounts produces dizziness, headache and nausea. EPA's Carcinogen Assessment Group has designated benzene as a human carcinogen (leukemogen).

Benzene demonstrated teratogenic effects in laboratory animals. Chromosomal changes have also been demonstrated in workers exposed to benzene.(28)

For maximum protection of human health from the potential carcinogenic effects of exposure to benzene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of benzene estimated by the Agency's Carcinogen Assessment Group to result in additional lifetime cancer risk at levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00015 mg/l, 0.0015 mg/l, and 0.015 mg/l, respectively.(29)

Because benzene is soluble in water, it could be leached from the wastewater treatment sludge which would be generated from treatment of the combined wastewaters, in a landfill situation and pose a threat to groundwater supplies. Because

it is also volatile (vapor pressure = 100 mm at 26.1°C (Appendix B.)), it may pose an inhalation hazard during handling in transportation and disposal. Additional information on the adverse health and environmental effects of benzene can be found in Appendix A.

Nitrobenzene

Nitrobenzene has toxic reproductive effects: in rats it delays embryogenesis, alters normal placentation, and produces abnormal fetuses (14); changes in the tissues of the chorion and placenta have been reported in women exposed to nitrobenzene (15). Nitrobenzene has been listed as a Priority Pollutant in accordance with §307(a) of the Clean Water Act of 1977.

With present data, it is not possible to fully estimate its aquatic fate. Hydrolysis and volatilization from water are considered unlikely. Adsorption onto humus and clay, and subsequent production by weathering and biological action, of (carcinogenic) benzidine and diphenylhydrazine could be a major fate pathway (12) Nitrobenzene is neither stored nor ecologically magnified, but is resistant to degradation by soil microflora (11, 12). In mammalian systems nitrobenzene is metabolized to aniline, nitrophenol, p-hydroxyaniline and other metabolites, which are excreted in urine, but such metabolism in man is slower by an order of magnitude than in animals (13).

The criterion to protect freshwater aquatic life is 480 ug/l (24 hour average). The occupational exposure limit

(OSHA) is 5 mg/m^3 (skin, 8 hr TWA). The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit for industrial exposure to nitrobenzene is 1 ppm.[23] Additional information on the adverse health effects of nitrobenzene can be found in Appendix A.

Aniline

Aniline is an experimental carcinogen (18). Its absorption causes anoxia due to the formation of methemoglobin, but significant chronic problems (other than animal carcinogencity) have not been demonstrated. Human exposure to vapor concentrations of mm has been observed to cause slight symptoms.[30] Rapid absorption through the intact skin is frequently the route of entry.[16,30] Cyanosis is the most prominent outward symptom of aniline intoxication.[8] At 0.4 mg/l aniline is toxic to Daphnia (8). OSHA's PEL for aniline is 19 mg/m^3 (skin, 8 hr TWA)(17). Additional information on the adverse health effects of aniline can be found in Appendix A.

Phenylenediamine

Phenylenediamine is a highly toxic substance (18), continued exposure to which can cause liver injury. It is a suspected carcinogen and teratogen (18). Of the three isomers, the p-substituted compound is by far the more toxic (19). The relative concentrations of these isomers in the listed waste are not known. The oral toxicity for human beings is high (LD_{10}= 50 mg/kg (19)), so the high water solubility of this compound is worrisome. Phenylenediamine is listed

by DOT as a hazardous substance (ORM-A), and the OSHA PEL is 0.1 mg/m^3(8 hr TWA) (17).

Diphenylamine

Diphenylamine is an experimental carcinogen and teratogen (19). Chronic exposure to diphenylamine induces cystic lesions in the chicken[20] and the rat.[24] The American Conference of Industrial Hygienists has established 10 mg/m^3 as an acceptable TLV for occupational exposure (21). Diphenylamine can also be expected to bioaccumulate, due to a high octanol/water partion co-efficient of 2,200 (7).

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HAZARDOUS WASTE LISTING BACKGROUND DOCUMENT

Distillation or Fractionating Column Bottoms from Production of Chlorobenzenes (T)

Separated Aqueous Stream from the Reactor Product Washing Step in the Batch Production of Chlorobenzenes (proposed) (T)*/

Distillation or fractionation column bottoms from the production of chlorobenzenes**/, and the separated aqueous waste stream from the reactor product washing step in the batch production of chlorobenzenes, are composed of a varying mixture of chlorobenzenes (dichlorobenzene through hexachlorobenzene) and benzyl chloride, and may also contain benzene and monochlorobenzene. The Administrator has determined that these waste streams are solid wastes and as solid wastes may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, disposed of, transported or otherwise managed. Therefore, these wastes, should be subject to appropriate management requirements under Subtitle C or RCRA. This conclusion is based on the following considerations:

1. Distillation or fractionating column bottoms from chlorobenzene production are likely to contain significant concentrations of dichlorobenzenes, trichlorobenzenes, tetrachlorobenzene, pentachloroben-

*/This waste stream was not included in the original waste listing, and thus is being initially proposed in the present document.

**/Throughout this background document, the terms 'chlorobenzene' and 'chlorinated benzene' are used synonomously.

zene and hexachlorobenzene. Benzyl chloride is also expected to be present in significant concentrations. Benzene and monochlorobenzenes may also be present in lesser concentrations depending on the efficiency of distillation . The dichlorobenzenes, trichlorobenzenes and tetrachlorobenzenes are all toxic. Hexachlorobenzene and benzene have been identified as having substantial evidence of carcinogenicity by the Carcinogen Assessment Group. Pentachlorobenzene has been reported to induce cancers in some animal species. Benzyl chloride is reportedly carcinogenic. Monochlorobenzene is toxic. All of the chlorobenzenes are also highly bioaccumalative.

2. The separated aqueous waste stream from the batch production of chlorozenzenes is believed to contain significant concentrations of benzenes, and also contains the various chlorobenzenes, and probably phenols and chlorinated phenols, some of which are carcinogens, and all of which present acute and chronic toxicity hazards.

3. These waste constitiuents are capable of migration, mobility and environmental persistence if managed improperly, and have caused substantial hazard in actual damage incidents. Disposal of these distillation bottoms and the aqueous waste in uncontrolled landfills, therefore, could allow migration of contaminants to ground and surface waters and release of volatile toxicants to the air, while improper incineration may result in the generation of extremely hazardous compounds such as phosgene.

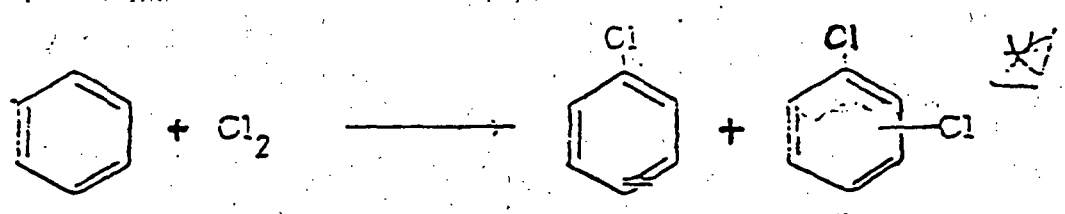
I. Industry Characterization and Manufacturing Process (1)

There are twelve chlorinated benzene compounds that can be formed during the chlorination of benzene including monochlorobenzene, three isomers of dichlorobenzenes, three of trichlorobenzenes, three of tetrachlorobenzenes, pentachlorobenzene and hexachlorobenzene.

Monochlorobenzene is the dominant commercial product; in 1978, production was approximately 134,000 metric tons.(1)

Production of ortho- and para-dichlorobenzene was estimated at 10,000 metric tons each for that same year.(1) Production of 1,2,4-trichlorobenzene was 13,000 metric tons in 1973. It is estimated that approximately the same amount was produced in 1977.(1) Statistics for other chlorobenzenes are unavailable because they have limited commercial value and their production is limited to their formation as by-products.(1) Major producers of chlorobenzenes in the United States include: Allied Chemical Corporation (Syracuse, New York); Dow Chemical Company (Midland, Michigan); Monsanto Company (Sauget, Illinois); Montrose Chemical Corporation of California (Henderson, Nevada); PPG Industries, Inc. (Natrium, West Virginia); Specialty Organics, Inc. (Irwindale, California); and Standard Chlorine Chemical Company, Inc. (Delaware City, Delaware).(2)

Chlorobenzene, dichlorobenzenes, and higher chlorinated benzenes are produced in batch and in continuous processes by direct chlorination of benzene in the presence of a Friedel Craft catalyst, such as ferric chloride, as shown in the following reaction for monochlorobenzene:



*/ 1,3-Dichlorobenzene, 1,3,5-trichlorobenzene and 1,2,3,5-tetrachlorobenzene are not produced by the method discussed below.

Because higher chlorinated benzenes always result from the direct chlorination of benzene, chlorobenzene production is a multiple product operation, i.e. a whole range of chlorinated benzenes may be produced. Product ratios are influenced by temperature, mole ratios of the feedstocks, residence time, and the catalyst. Additionally, the crude reaction product of a continuous process may be recycled to the process to achieve the desired final product mixture. Depending on the final product mixture, chlorobenzenes are purified by fractional distillation and/or crystallization. Continuous chlorination processes, in contrast to batch processes, minimize the amount of higher chlorinated products, thereby maximizing monochlorobenzene yields.

A. Production of Monochlorobenzene

1. Continuous Process (modified from Reference 1,6,7)

As shown in Figure 1 (p. 5A), in a typical continuous process for the production of chlorobenzenes, anhydrous benzene and chlorine are introduced into a reactor operating at a bottom temperature of 90-125°C and a top temperature of about 80°C. Benzene is introduced near the top of the column, and an equimolar amount of chlorine is introduced near the midpoint of the reactor. A variety of catalysts may be used, usually iron or ferric chloride impregnated on a suitable carrier.

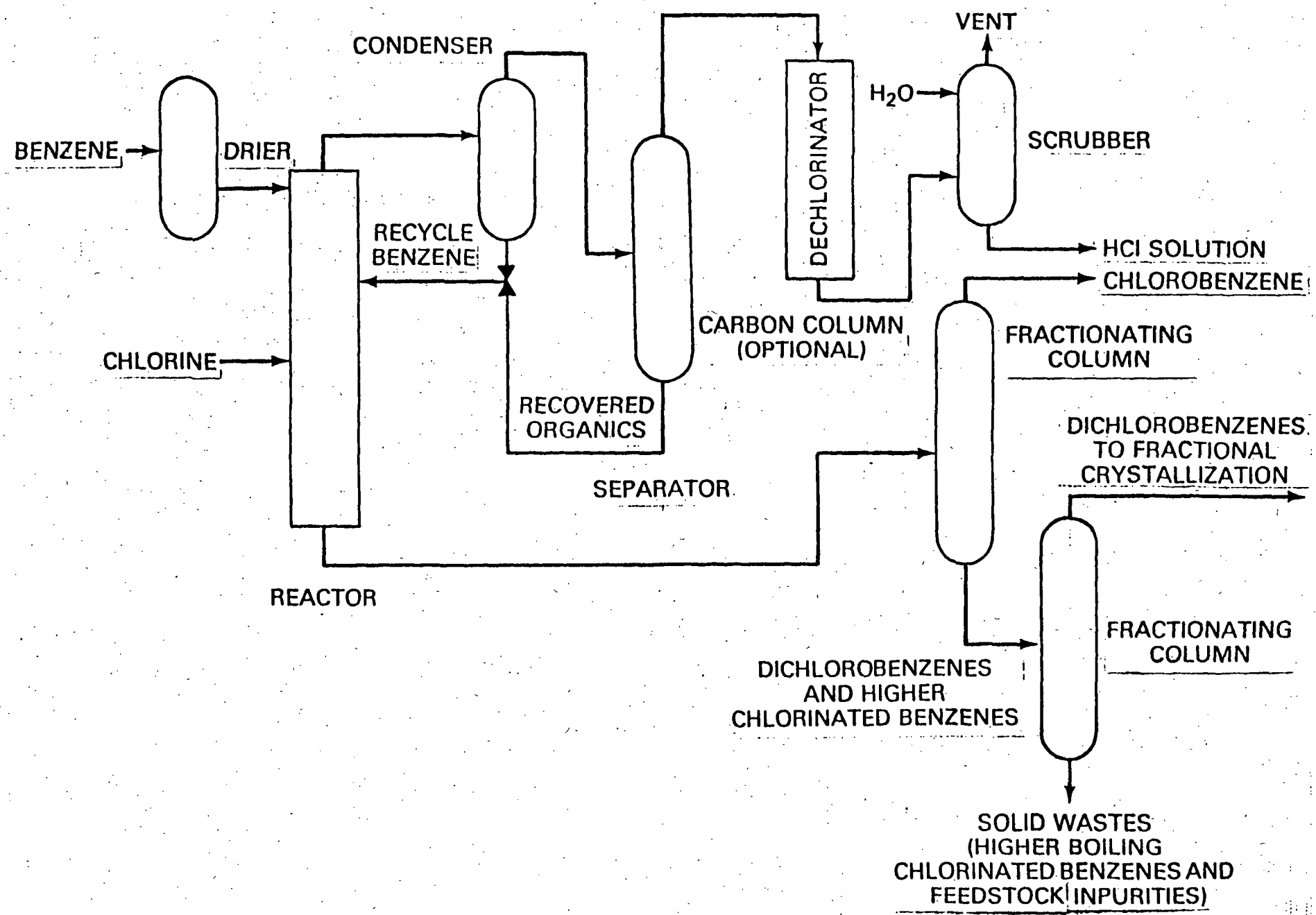


FIGURE 1
CONTINUOUS PRODUCTION OF CHLOROBENZENE (MODIFIED FROM 7)

The overhead reactor effluent consisting of hydrogen chloride and benzene passes through a condenser which condenses the benzene for recycle. Hydrogen chloride is recovered by passing the uncondensed gas through a scrubber tower containing a chlorination catalyst, thereby removing unreacted chlorine. The mixture is then passed through one or more towers in which chlorobenzenes are used to remove organic contaminants. The resultant hydrogen chloride is then recovered as either an anhydrous product or as a 30-40% aqueous solution. (If the hydrogen chloride must meet a low organic specification, a carbon column may be used prior to or after the water absorption tower.)

The bottom effluent from the reactor comprises an equilibrium mixture of benzene and mixed chlorobenzenes. To maximize monochlorobenzene production, a high recycle rate of benzene is maintained (20:1). Chlorobenzene is withdrawn at a rate equal to that at which benzene is fed and chlorinated, and flows to a fractionating column which operates at a bottom temperature of aproximately 190°C and top temperature of 140°C. The higher boiling bottom products (mostly dichlorobenzenes) are continuously bled at approximately 2% of the product feed to a fractionating column for recovery of the di- and trichlorobenzenes. The wastes of concern are the bottoms from the two fractionating columns.*/

*/ In some processes, this further fractionating step for recovery of higher chlorobenzenes will not occur, in which case the waste of concerns are the column bottoms from the first fractionating column.

2. Batch Process

Chlorobenzenes may also be manufactured by a batch process as shown in Figure 2. Dry benzene is charged into an agitated glass-lined or iron (steel) agitated reactor. Either iron turnings or anhydrous ferric chloride are used as a catalyst and remain in the chlorinator after each batch. Chlorine is added to the reactor at a rate to keep the temperature between 20° to 60°C. If monochlorobenzene is the desired product, the reaction temperature is maintained in the range of 20° to 30°C for 10 to 16 hours and about 60 percent of the stoichiometeric requirement of chlorine used. If poly-substituted chlorobenzenes (generally dichlorobenzenes) are desired in addition to monochlorobenzene, the reaction is run at a temperature of 55° to 60°C for approximately six hours.

Hydrogen chloride is recovered in a manner similar to that of continuous processes by scrubbing with chlorobenzene to remove organic contaminants and absorbing the product gas in water to give hydrochloric acid. The chlorobenzene product is washed in an agitated reactor with an aqueous solution of sodium hydroxide (10 percent by weight). The separated aqueous layer is a separate waste stream, and is the second waste stream included in this listing.*/

*/No such aqueous stream is expected to be present in continuous processes, since during the stripping step in the continuous process (see Fig. 1) the temperature at the bottom of the condenser column already removes residual hydrogen chloride and benzene, and makes a product washing step unnecessary.

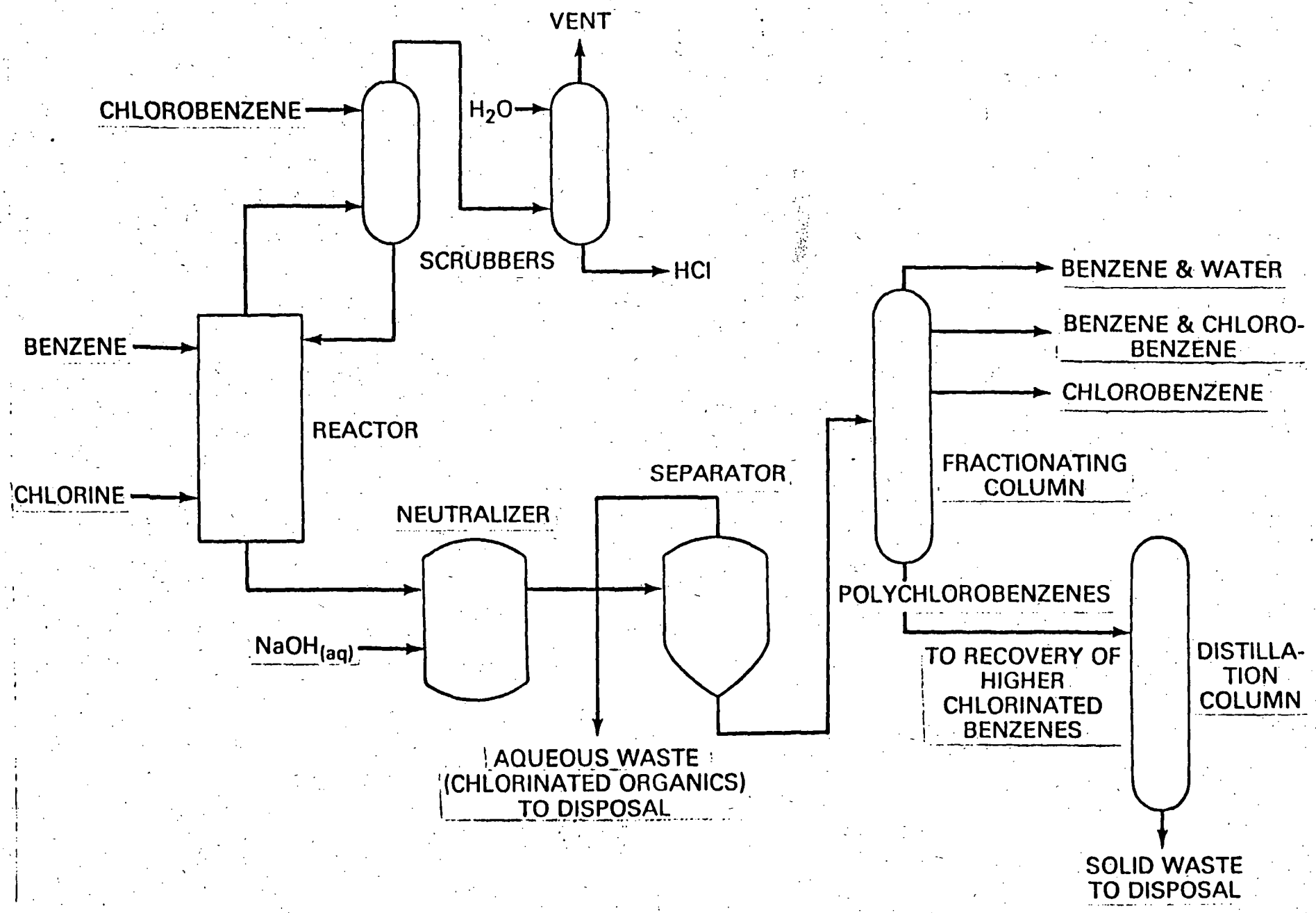


FIGURE 2
BATCH PRODUCTION OF CHLOROBENZENES (MODIFIED FROM 6)

After the neutralized organic layer is separated, it is sent to a fractionation column for product separation. A typical product distribution from fractionation is shown in Table 1 for a fully chlorinated batch for which 100 percent of the theoretical amount of the chlorine requirement for monochlorobenzene has been consumed is given.

TABLE 1

PRODUCT DISTRIBUTION OF A CHLOROBENZENE BATCH REACTION (6)

Component	% by weight
Benzene and water	3
Benzene and chlorobenzene	10
Chlorobenzene	75
Chlorobenzene and dichlorobenzene	10
Tar (trichlorobenzene and higher)	2

Most batch processes will include a further distillation step to separate higher chlorinated benzenes, particularly o- and p-dichlorobenzene and trichlorobenzene.*/ The chlorobenzene and dichlorobenzene fraction is usually further distilled to recover p-dichlorobenzene and o-dichlorobenzene. Trichlorobenzene may also be recovered. The tarry residue--the solid waste of concern-- consists chiefly of trichloro and higher chlorinated benzenes.

*/Table 1 is a product mix prior to this second distillation step.

B. Production of Polychlorobenzenes

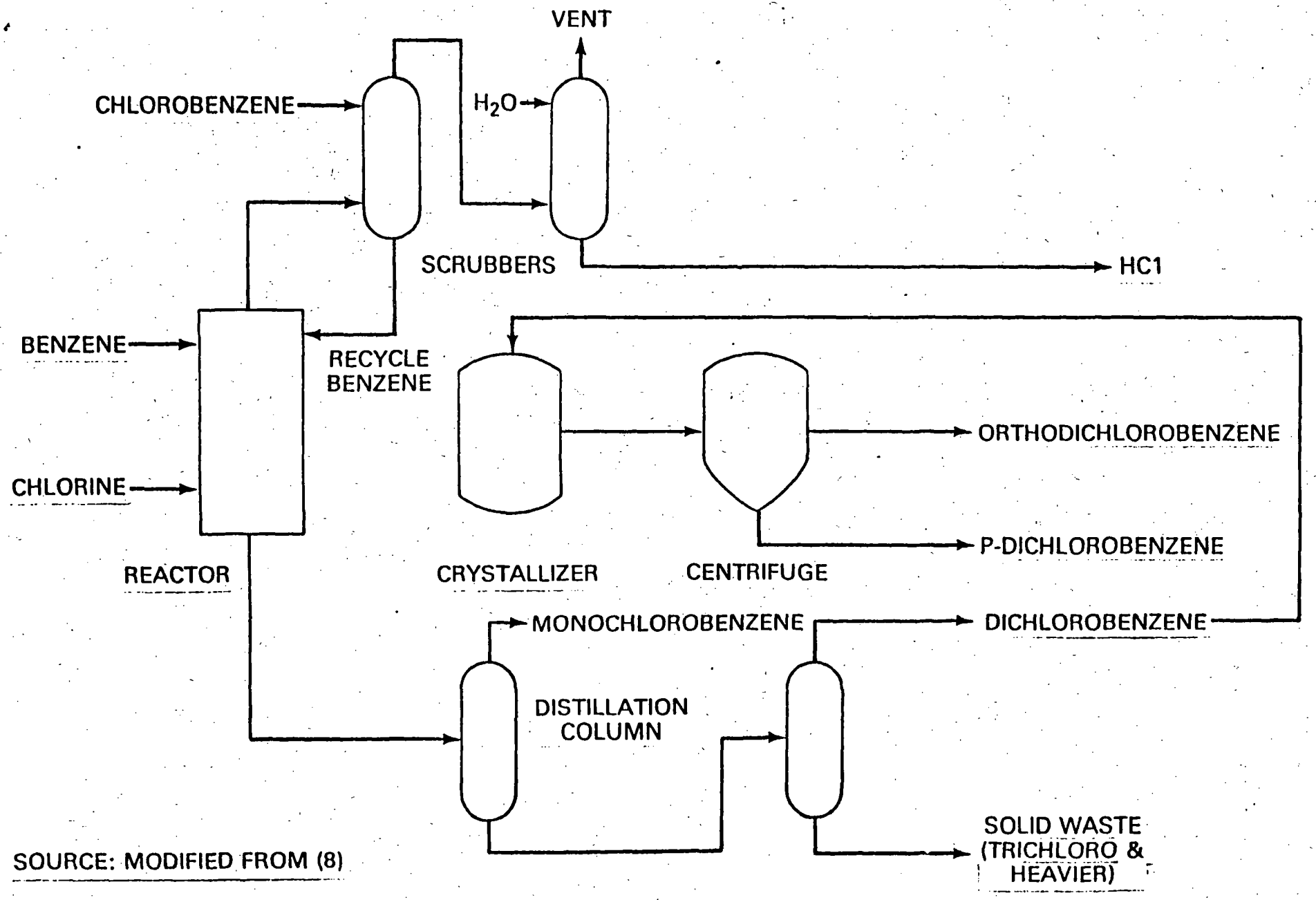
As noted previously, aromatic chlorination is a multiple product process; most polychlorobenzenes can be produced via processes similar to those described above. Reaction conditions are, however, likely to be somewhat different. Higher reaction temperatures, and longer reaction times and higher chlorine to benzene ratios are likely modifications. A process configuration for production of dichlorobenzenes is shown in Figure 3.

Dichlorobenzenes

Dichlorobenzenes are co-products of the production of monochlorobenzene using a ferric chloride catalyst. Separation of o- and p-dichlorobenzene is difficult by fractional distillation (bp-6°C), and so is accomplished by fractional crystallization.

Trichlorobenzenes

As noted previously, both 1,2,4-and 1,2,3-trichlorobenzene are produced as co- or by-products of the catalytic chlorination of benzene. Isomers may be separated by fractional crystallization.

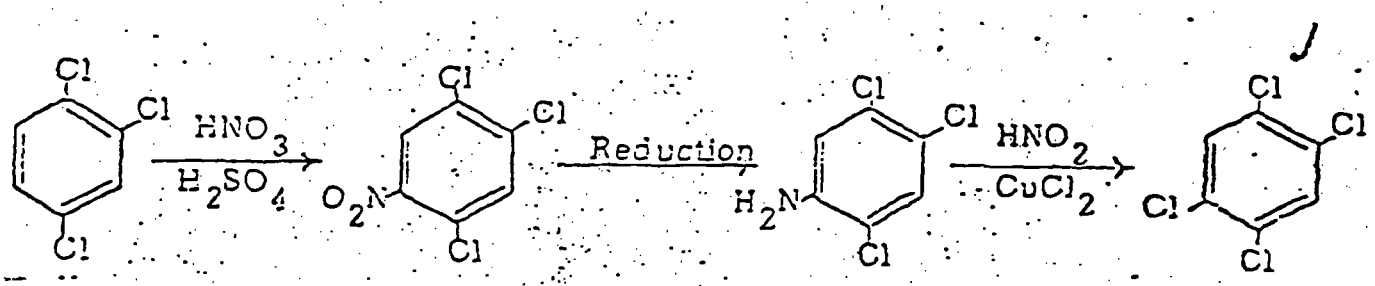


SOURCE: MODIFIED FROM (8)

FIGURE 3
PRODUCTION OF HIGHER CHLOROBENZENES

Tetrachlorobenzenes

There are three isomeric tetrachlorobenzenes: 1,2,3,4-tetrachlorobenzene; 1,2,3,5-tetrachlorobenzene; and 1,2,4,5-tetrachlorobenzene. Of these isomers, the 1,2,4,5- isomer is a chemical and pesticide intermediate (hexachlorophene, Isobac 20, Ronnel, Silvex, and 2,4,5-T). Each isomer can be produced by catalytic chlorination using an aluminum chloride catalyst. 1,2,4,5-Tetrachlorobenzene may also be produced via the Sandmeyer reaction:



Pentachlorobenzene and Hexachlorobenzene (8,9)

Pentachlorobenzenes are formed by the chlorination of benzene in the presence of ferric or aluminum chloride at temperatures of 150 to 200°C, or by the chlorination of any of the lower chlorobenzenes.

Hexachlorobenzene is reported not to be produced commercially via catalytic (ferric chloride) chlorination of benzene. When generated as a by-product of the processes described in this document, it is not recovered and is found in the fractionating column bottoms.

II. Waste Composition and Management

1. Fractionation Bottoms

The distillation or fractionation bottoms from the production of monochlorobenzene consist primarily of the higher polychlorinated benzenes (trichlorobenzenes and higher), benzyl chloride and chlorotoluenes*/ resulting from the chloronation of toluene impurities in benzene feedstock, and lesser concentrations of feedstock benzene, product chlorobenzene, and dichlorobenzenes (depending on the efficiency of the fractionating step). The relative concentrations of the various chlorobenzenes in these wastes vary according to reaction conditions and the efficiency of fractionation. In general, when monochlorobenzene is the favored by-product, dichlorobenzene will probably be the most prevalent of the

*/Both o- and p-chlorotoluene also are expected to be present. These constituents are not considered to be of regulatory concern because of their low chronic toxicity. Further information as to the validity of this conclusion is solicited, however.

chlorinated benzenes in the distillation residue (and in the waste if there is no subsequent distillation step to recover dichlorobenzenes as product) since benzene is being chlorinated for less time, so that smaller concentrations of tetra- to hexachlorobenzene are formed. If dichlorobenzenes are recovered as product, then trichlorobenzenes will represent the greatest fraction in the waste. When the reaction is pushed in the direction of polychlorinated benzenes, there will be more trichloro through hexachlorobenzene in the waste stream.

Waste composition, and especially the concentrations of the various chlorinated benzenes, also will vary quantitatively, although not qualitatively, depending on whether a continuous or batch production process is used. Batch processes would tend to have somewhat higher concentrations of higher chlorinated benzenes, since benzene chlorination occurs for a longer period.

Table 1 (p. 8 above) gives an estimate of wastes resulting from a batch reaction favoring monochlorobenzene production. As noted, distillation tars are estimated to consist principally of the higher chlorinated benzenes (trichlorobenzene and higher). These tars would comprise roughly 2% by weight of the total reaction products and byproducts.

Table 2 gives a second estimate of waste composition from a batch process favoring monochlorobenzene. The polychlorinated tars are the listed hazardous wastes. Benzene and chlorobenzene would be vented to the atmosphere, since

they have lower boiling points, though small concentrations of these constituents would be expected to remain in the distillation bottoms. In addition, some dichlorobenzenes would be present from the recovery of dichlorobenzenes by subsequent distillation.

Table 2[9]

ESTIMATED LOSS OF MATERIALS DURING CHLOROBENZENE MANUFACTURE (BATCH PROCESS)

Chemical	Source	Quantity Produced (Kg/kg monochlorobenzene)
Hydrogen Chloride (catalyst; nonhazardous)	Hot scrubber vent	0.0014
Monochlorobenzene	Dichlorobenzene Column	0.00088
Dichlorobenzenes (isomers not specified)	"	0.0037
Monochlorobenzene	Fractionating Towers	0.004
Dichlorobenzenes	"	0.0001
Polychlorinated Distillation Tars	Distillation Residues	0.044

A third reference (shown in Table 3) taken from the patent literature and involving a continuous process, shows monochlorobenzene present in fairly substantial concentrations in the solid waste, as well as the same ranges of heavier chlorinated benzenes.

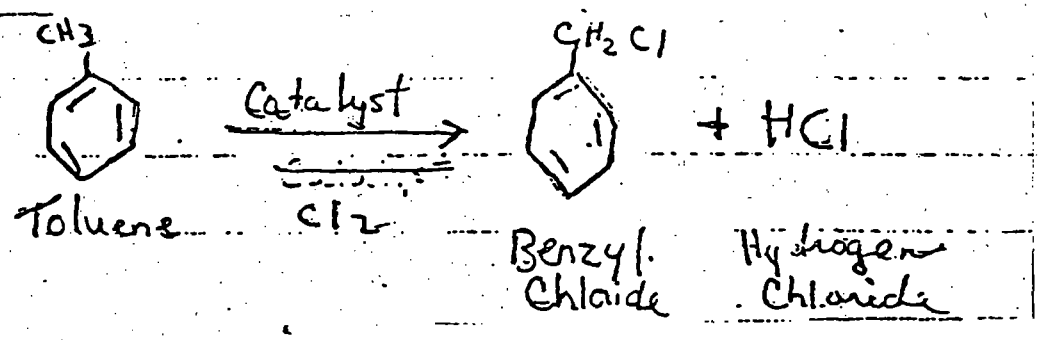
TABLE 3

ESTIMATED EMISSIONS FROM CHLOROBENZENE MANUFACTURE:
Chlorination of Benzene, Continuous Process

	Emmissions kg/Mg		
Species	Air	Aqueous	Solid
Benzene			trace
Chlorobenzene			2.6
Polychlorinated benzenes			31
			33.6

Source: Derived from Hunter, W. K., Combination Reaction-Fractionation U.S. Patent 3,366,457, January, 1968.

These wastes (from both continuous and batch processes) are also expected to contain significant concentrations of benzyl chloride and o- and p-chlorotoluene resulting from chlorination of toluene impurities in benzene feedstock.*/ (As noted above, the chlorinated toluenes are not waste constituents of concern). The specific reaction pathways for these constituents are given below:



*/ Toluene is believed to be the most significant feedstock impurity. Benzene may typically contain up to 1% toluene Mellan, I. Industrial Solvents Handbook, 2nd Ed., Noyes Data Corp., Park Ridge, NJ, 1977.

These side reactions are believed to be those most likely to occur under usual conditions of benzene chlorination. Virtually all of these substances would be present in the distillation bottoms since they are high boiling chemicals that the distillation process is designed to eliminate.

2. Separated Aqueous Stream from the Reactor Product Washing Step (batch process)

The aqueous stream from the reactor product washing step in the batch production of chlorinated benzenes will contain benzene, and all of the chlorinated benzenes in solution (along with water and caustic soda used in the washing operation). Since this is an aqueous waste, concentrations of these constituents will depend on their solubilities in the somewhat alkaline wash solution. While the Agency does not presently have precise information on these compounds' solubility in basic solutions, it is not believed to differ significantly from their solubilities in water (if anything, solubilities would be slightly higher in basic solutions). Thus, the highly soluble benzene (water solubility reported at up to 1,780 ppm) would probably be the principal waste constituent, and monochlorobenzene and o- and p-dichlorobenzene would also be present in fairly significant levels (water solubilities from 79 ppm to 488 ppm respectively) would also be present in significant concentrations. The remaining chlorinated benzenes would be present at much lower levels, since their solubilities are quite low. (Solubility data is from App. B.) Phenols

could also be formed if temperatures are sufficiently high to create hydrolysis conditions, and a highly alkaline wash mixture is used. Chlorinated phenols could also be present from the phenolization of the di- and tri-chlorobenzenes, although concentrations of phenols and chlorinated phenols would probably be small.

Table 4 below shows organic contaminants found in the wastewater stream from chlorobenzene manufacture at a Dow plant.

TABLE 4

PRIORITY POLLUTANTS IDENTIFIED IN AQUEOUS WASTESTREAM FROM PRODUCT WASHING STEP IN PRODUCTION OF CHLOROBENZENES(29)

	Concentration mg/l	Loading kg/day

*The underlined data are those obtained from proprietary reports and data files.

3. Waste Management

Waste management practices for the distillation residues generally involves disposal in on-site and off-site landfills (1). Incineration is also practiced to destroy toxic constituents (9).

The separated aqueous stream generally is sent to wastewater treatment.(1) The most feasible treatment method is activated carbon preceded by sand filtration.(1) A wastewater treatment sludge is generated which is assumed to be hazardous unless generators show otherwise. (See §261.3(a)(2)(ii).)

III. Hazards Posed by the Waste

As noted above, the distillation wastes are expected to contain significant concentrations of tri- through hexachlorobenzene, and benzyl chloride, lesser concentrations of dichlorobenzenes, and some monochlorobenzene and benzene. Furthermore, the waste stream will consist almost completely of these organic contaminants. Hexachlorobenzene and benzene have been identified as having substantial evidence of carcinogenicity by the Carcinogen Assessment Group. Pentachlorobenzene is reported to induce cancers in some animal species. Benzyl chloride is reportedly carcinogenic. The remaining constituents present acute and chronic toxicity hazards. All are priority pollutants.
In addition, all of the chlorinated benzenes are very bioaccumulative (based on extremely high octanol/water partition coefficents (see pp. 23 - 28 below)) and so could pose an additional hazard even if exposure is only to small concentrations of the pollutant.

The aqueous wastestream will contain benzene, chlorobenzenes through trichlorobenzene, and (under certain conditions) certain phenols and chlorinated phenols. 2,4-dichlorophenol and 2,4,6-trichlorophenol have been identified by the Carcinogen Assessment Group as having substantial evidence of carcinogenicity. In addition, both compounds present acute and chronic toxicity hazards. 2,4,6-trichlorophenol is also mutagenic.

In light of the reported concentrations of these hazardous constituents, these waste streams are clearly of regulatory concern. Indeed, for the carcinogens in the wastes, there is no known safe level of exposure, every exposure likely giving rise to at least one cancer in a defined portion of population, regardless of exposure concentration. (EPA Water Quality Criteria, 44 Fed. Reg. 15926, 15930 (March 15, 1979).) The Agency thus requires strong assurance that these waste constituents are incapable of migration, mobility, and persistence in the event of improper management to justify not listing this class of wastes. Such assurance does not appear possible.

All of the waste constituents have proved capable of migration, of mobility through soils, and of environmental persistance in the course of actual waste management practice, creating a substantial potential for hazard. Benzene and all of the chlorinated benzenes through pentachlorobenzene have been detected in air, basement sump and solid surface samples collected in the vicinity of the Love Canal waste disposal

site in Niagra, New York.(5) Benzyl chloride has been identified as leaching from Hooker's Hyde Park site in Niagra, New York (OSW Hazardous Waste Division, Hazardous Waste Incidents, Open Files, 1978), and has been shown to persist in the atmosphere in the New Jersey area for considerable periods of time (Altshuller, A. P., Lifetimes of Organic Chemicals in the Atmosphere, Environmental Scientific Technology, 1980, in press).

Hexachlorobenzene has likewise been shown to migrate via air and groundwater pathways and to persist following migration. One notorious damage incident involving hexachlorobenzene occured in Louisiana in the early 1970s. Exposure to hexachlorobenzene resulted via inhalation from transport of hexachlorobenzene-contaminated wastes, resulting in dangerously elevated hexachlorobenzene concentrations in humans and animals along the route. (OSW Hazardous Waste Management Division, Hazardous Waste Incidents, unpublished, Open Files, 1978.) Hexachlorobenzene has also been detected in concentrations exceeding background levels in many groundwater monitoring samples taken at various locations at a chosen chemical company dump. (1 at Table 7.2.)

The phenols and chlorinated phenols present in the waste water stream also are capable of migration, mobility, and persistence. Phenol and 2-chlorophenol are extremely soluble in water (App. B) and, although subject to biodegradation (id.),

could persist for long periods of time in the abiotic conditions characteristic of most aquifers. Both 2,4-dichlorophenol and 2,4,6-trichlorophenol are likewise quite soluble in water and do not exhibit a high propensity to adsorb in soils.(30) Migratory potential is thus substantial, and if migration occurs, these chlorinated phenols are mobile and persistent. For example, in a damage incident at Montebello, California, involving wastes from 2,4 dichlorophenol manufacture, 2,4-dichlorophenol and other phenolic compounds proved capable of passing through soils and causing longterm pollution of groundwater. (Sinenson, H.A., 1962. The Montebello Incident., Proc. Assoc. Water Treatment and Exam. 11:84-88.) Contamination of groundwater by 2,4-dichlorophenol and other hazardous compounds has also been reported in East St. Louis, Ill. The source of the compounds was the Monsanto chemical dump. (EPA Office of Solid Waste, Hazardous Waste Division, Hazardous Waste Incidents, unpublished, open file 1978.)

Since all of the waste constituents of concern have proven capable of migration, mobility, and environmental persistence, and have in fact caused substantial hazard in acutual waste management practice, the Agency believes that the waste constituents could migrate and reach environmental receptors if the wastes are improperly managed. Landfilling the waste without adequate cover could easily result in volatilization of hexachlorobenzene and benzene. Solubilization of hazardous compounds could occur

if rainwater is allowed to percolate through the waste or run off the surface of exposed waste. Waste constituents could then be released if landfills are improperly designed (built without leachate control in areas with permeable soil or located in areas where soils have low attenuative capacity), or managed. Improperly designed wastewater treatment ponds pose the same risk. In the case of improperly managed landfills, surface run-off might also transport compounds that have adsorbed to suspended particulates. Contaminant-bearing leachate and surface run-off may eventually enter ground and surface waters, polluting valuable water supplies and adversely affecting aquatic organicsms.

Improper incineration of the distillation residues provides another means by which toxic compounds can be generated and introduced into the environment. If incineration is inadequate (for instance, if temperatures are insufficient or residence time incomplete), inadequate combustion can result in the formation of substances (such as phosgene) that are even more toxic than the original waste.(1) These contaminants can be emitted from the incinerator to the atmosphere and dispersed in the environment.

IV. Health and Ecological Effects

Health and ecological effects and potential transport mechanisms for the constituents of concern that might be found in the distillation bottoms and the separated aquaeous waste stream from manufacture of chlorobenzenes are described below:

Benzene

Health Effects Benzene is a human carcinogen. Exposure to benzene as a result of inhalation induces abnormalities in the blood and causes leukemia.(31-3) Benzene administered subcutaneously has been teratogenic in mice at extremely low doses [3 ml/Kg].(34) Chronic inhalation of this chemical in low doses by rats has caused both inhibition and resorption of embryos.(35) Benzene is also mutagenic when administered orally to mice at extremely low doses [1 mg/Kg].(36)

Exposure of humans to benzene has resulted in the reduction of blood cells, impairment of the immunologic system, aplastic anemia and a variety of mutagenic effects in lymphocytes and bone marrow.(37-42) Oral ingestion of benzene in small amounts (50 mg/Kg), or one-seventieth of the oral LD_{50} in rats, has been lethal in humans.(43)

Regulatory Recognition of Hazard - OSHA has set a revised TLV for benzene at 10 ppm with a maximum permissible exposure of 30 ppm for 10 minutes, within EPA the Offices of Water and Waste Management, and Air Quality Planning and Standards and Toxic Substances are performing a pre-regulatory assessment of benzene based on its environmental effects, high-volume production, spill reports and other health effects. Additionally, benzene has been identified by the Agency as having substantial evidence of being carcinogenic. The Consumer Product Safety Commission requires benzene to carry special labelling.

Industrial Recognition of Hazard - Benzene is designated as highly toxic in handbooks used by industry, such as Plunkett, Handbook of Industrial Toxicology.(44) According to Sax, Dangerous Properties of Industrial Materials(45), benzene represents a fire and moderate exposure hazard.

In addition, benzene is a priority pollutant in accordance with §307 of the Clean Water Act of 1977 and is listed as a hazardous waste or hazardous waste constituent in final or proposed regulations of California, Maine, New Mexico and Oklahoma.

Additional information on the health and ecological effects of benzene may be found in Appendix A.

Chlorobenzenes: Chlorobenzenes are products of the main reaction. Their acute toxic effects are moderate but, because they bioaccumulate to a significant degree, chlorobenzenes may pose a substantial hazard if chronic exposure occurs. They are relatively mobile in the environment and likely to persist for long periods of time.

Chlorobenzene (Monochlorobenzene, MCB)

Health effects - Monochlorobenzene is a central nervous system depressent, with the typical anesthetic effect(46); degeneration of the liver and kidney may develop concurrently with anesthesia produced by this chemical. Acute inhalation of monochlorobenzene has induced narcosis, neuropathy and death in animals during acute inhalation studies.(47) The metabolism of monochlorobenzene may lead to the formation of carcinogenic active

intermediates.(48) Monochlorobenzene is also very bioaccumulative with an octanol/water partition coefficient of 690 (App. B).

Regulatory Recognition of Hazard - The OSHA standard for chlorobenzene is a TWA of 75 ppm. EPA's Office of Water and Waste Management provides technical assistance data and regulation for chlorobenzene under Section 311 of the Clean Water Act. They are also involved with pre-regulatory assessment under the Safe Drinking Water Act. The Office of Air, Radiation and Noise and the Office of Research and Development are involved with pre-regulatory assessment under the Clean Air Act. The Office of Toxic Substances is involved with test rule recommendations under Section 4(e) of the Toxic Substances Control Act.

Monochlorobenzene also is listed as a priority pollutant in accordance with §307 of the Clean Water Act of 1977, and final or proposed regulations of Maine, New Mexico, Oklahoma and California list chlorobenzene as a hazardous waste or a component of hazardous waste. The American Conference of Governmental Industrial Hygienists (ACGIH, 1971) threshold limit value for monochlorobenzene is 350 mg/m^3.

A more detailed discussion of monochlorobenzene may be found in Appendix A.

Dichlorobenzenes: Ortho- and paradichlorobenzene are products of the main reaction. They are very bioaccumulative, each having an octanol/water partition coefficient of 2500

(Appendix B). A discussion of each isomer follows.

ortho-Dichlorobenzene

Health Effects - Ortho-dichlorobenzene is very toxic in rats [oral LD_{50} = 500 mg/Kg].(49) Human death has also occurred at this level.(50) Chronic occupational exposure to this chemical and its isomer has resulted in toxicity to the liver, central nervous system and respiratory system.(51) Chronic oral feeding of ortho-dichlorobenzene to rats in small doses has caused anemia as well as liver damage and central nervous system depression.(52)

Regulatory Recognition of Hazard - Ortho-dichlorobenzene has been designated as a priority pollutant under Section 307(a) of the CWA. The OSHA standard for o-dichlorobenzene is 50 ppm for an 8-hour TWA. It was selected by NCI for Carcinogenesis Bioassay, September 1978. o-dichlorobenzene is listed as a hazardous waste or a component thereof in final or proposed regulations of the States of California, New Mexico and Oklahoma. The Occupational Safety and Health Administration standard and the American Conference of Government Industrial Hygienists threshold values for o-dichlorobenzene is 300 mg/m^3. The U.S. EPA draft water quality criterion for total dichlorobenzene is 0.16 mg/l. U.S. EPA has also established criteria for freshwater and marine aquatic life.

para-Dichlorobenzene

Health Effects - Para-dichlorobenzene is very toxic in rats (oral LD_{50} = 500 mg/kg](53)), having lethal effects in humans ingesting similar amounts.(54) Adverse effects are exerted on the liver and kidney function in humans at a smaller [300 mg/Kg] dose level.(55) This chemical has induced growth depression, liver cell necrosis and death in animals exposed by inhalation.(56)

Regulatory Recognition of Hazard - Para-dichlorobenzene has been designated as a priority pollutant under Section 307(a) of the CWA. p-Dichlorobenzene has an OSHA standard for air TWA of 75 ppm (SCP-T). It is listed as a hazardous waste or a component thereof in final or proposed regulations of the states of California, New Mexico, and Oklahoma. The Occupational Safety and Health Administration Standard and the American Conference of Government Industrial Hygienists threshold values for p-dichlorobenzene is 450 mg/m^3. A more detailed discussion of dichlorobenzene can be found in Appendix A.

Tetrachlorbenzene

Health Effects - There is some evidence of liver damage occuring with prolonged exposure of rats and dogs to tetrachlorobenzene. (11,18). Tetrachlorobenzene has an oral rat LD_{50} of 1500 mg/kg.(14) It is reported to be acutely toxic in varying degrees to some fresh- and saltwater organisms, and chronically toxic to saltwater organisms.(19) The octanol/water partition coefficient for 1,2,4,5-tetrachlorobenzene is extremely high, 47,000.(14) The predominant disposition site for tetrachlorobenzene is suspected to be, or shown to be, in the lipid tissues of the body.(16)

Tetrachlorbenzene is designated by Congress as a priority pollutant under §307 of the Clean Water Act of 1977.

Additional information on the toxic effects of tetrachlorobenzene can be found in Appendix A.

Pentachlorobenzene

Health Effects - Pentachlorobenzene was reported to be carcinogenic in mice, although not in rats or dogs.(21) It was also reported to have caused bone defects in the offspring of rats which had received doses of pentachlorobenzene during gestation.

Pentachlorobenzene is quite acutely toxic at low concentrations (ranging from 160 ug/l to 6,780 ug/l) to both salt- and freshwater organisms, including plants.

Pentachlorobenzene has an extremely high octanol/water partition coefficient of 154,000, indicating a dangerously high bioaccumulation potential.(14)

Pentachlorobenzene is designated as a priority pollutant under §307 of the Clean Water Act.

Additonal information on the adverse health effects of pentachlorobenzene can be found in Appendix A.

Hexachlorobenzene

Health Effects - U.S. EPA's Carginogen Assessment Group (CAG) has evaluated hexachlorobenzene and has found sufficient evidence to indicate that is is carcinogenic. It has also been demonstrated to be fetotoxic to rats.(23) The distribution of hexachlorobenzene is apparently the same in the fetus as in

the adults, with the highest concentration in fatty tissue. (23) This is expected because of its extremely high octanol/water partition coefficient of 168,000.(14)

Chronic exposure of rats to hexachlorobenzene has caused histological changes in the liver and spleen (24), and in humans, has caused porpyrinuria.(25)

Hexachlorobenzene is designated as a priority pollutant under §307 of the Clean Water Act.

Additional information on the adverse health effects of hexachlorobenzene can be found in Appendix A.

Benzyl Chloride

Health Effects - Benzyl chloride has been identified as a carcinogen(16), and is also mutugenic(27).

The OSHA TWA for benzyl chloride is 1 ppm. DOT requires labeling as a corrosive. The Office of Water and Waste Management, EPA, has regulated benzyl chloride under Section 311 of the Clean Water Act. Preregulatory assessment has been completed by the Office of Air, Radiation and Noise under the Clean Air Act. The Office of Toxic Substances has requested additional testing under Section 4 of the Toxic Substances Control Act.

Benzyl chloride is listed in Sax's Dangerous Properties of Industrial Materials as highly toxic via inhalation and moderately toxic via the oral route.

Additional information and specific references on the adverse effects of benzyl chloride can be found in Appendix A.

2,4-Dichlorophenol

Health Effects - 2,4-Dichlorophenol is very toxic in rats [oral LD_{50} = 580 mg/Kg].(61) This chemical is carcinogenic when applied to the skin of mice in small doses.(62) It is also reported to adversely affect cell metabolism.(63,64) An isomer, 2,6-dichlorophenol is also toxic in animals.(65)

2,4-Dichlorophenol has been designated as a priority pollutant under Section 307(a) of the CWA.

Ecological Effects - Small doses of 2,4-dichlorophenol have been lethal to freshwater fish and invertebrates.(66)

Regulations - The Office of Water and Waste Management has completed a pre-regulatory assessment of the proposed water quality criteria under sections 304(a) and 311 of the Clean Water Act. The Office of Research and Development is presently conducting a preregulatory assessment under the Clean Water Act.

Industrial Recognition of Hazard - Sax, Dangerous Properties of Industrial Materials(45), designated a toxic hazard rating of moderate toxicity of 2,4-dichlorophenol. However, chlorinated phenols are designated as highly toxic local and systemic compounds.

Additional information and specific references on the adverse effects of 2,4-dichlorophenol can be found in Appendix A.

2,4,6-Trichlorophenol

Health Effects - 2,4,6-trichlorophenol induced cancer in mice during long-term oral feeding studies.(67) It has also been acutely lethal to humans by ingestion of 60% of the oral

LD_{50} dose in rats [500 mg/Kg].(68) This chemical is reportedly mutagenic(69) and adversely affects cell metabolism.(70,71) 2,4,6-Trichlorophenol has been designated a priority pollutant under 307(a) of the FWPCA.

Ecological Effects - Very small concentrations of 2,4,6-trichlorophenol have been lethal to freshwater fish [LC_{50} = 175 - 426 mg/l].(72,73) This chemical is also lethal to freshwater invertebrates at very low concentrations.(73)

Industrial Recognition of Hazard - Sax, in Dangerous Properties of Industrial Materials(45), lists 2,4,6-Trichlorophenol as moderately toxic via ingestion.

Additional information and specific references on the adverse effects of 2,4,6-trichlorophenol can be found in Appendix A.

Phenol

Health Effects - Chronic exposures to phenol at high concentrations has caused chronic liver damage in humans (74). Exposure to acutely toxic levels of phenol causes central nervous system depression (75).

Phenol is reported to be acutely toxic to marine and freshwater organisms in widely varying degrees (75).

Phenol was found mutagenic *Drosophila* (a fruit fly) (76) and nonmutagenic in *Neurospora* (a mold) (77).

When phenol was administered to rats in their drinking water, adverse reproductive effects were noted at the various dose levels: stunted growth of young at 7,000 mg/l, death of offspring at birth at 10,000 mg/l, and failure to reproduce at

12,000 mg/l (78).

Additional information and specific references on the adverse effects of phenol can be found in Appendix A.

2-Chlorophenol

Health Effects - 2-Chlorophenol was found to induce a high incidence of papillomas (non-malignant skin warts) when repeatedly applied to mouse skin (although carcinomas were not induced) (79).

According to Sax, chlorinated phenols are highly acutely toxic through ingestion and inhalation and skin absorption and as irritants, both locally and systemically. Sax explains that his "high" toxic hazard rating is applied when a compound may cause death or permanent injury after very short exposure to small quantities (45).

2-Chlorophenol was reported acutely toxic in varying degrees at relatively low doses to some freshwater organisms (80).

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Ink Formulation

Veterinary Pharmaceuticals

LISTING BACKGROUND DOCUMENT

Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds (T).

Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds (T) (proposed)*/

Distillation tar residues from distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds (T) (proposed)*/

I. SUMMARY OF BASIS FOR LISTING

Treatment of wastewater from the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds generates a wastewater treatment sludge containing arsenic or organo-arsenic compounds. The production of this class of veterinary pharmaceuticals likewise generates other arsenic-containing wastes, proposed for listing in this document.

The Administrator has determined that these wastewater treatment sludges and other arsenic-containing wastes from the production of veterinary pharmaceuticals are solid wastes which pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and, therefore, should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

*/These waste streams were not included in the initial listing, and are being initially proposed in the present document.

1) These wastes have been shown to contain high concentrations of arsenic. Arsenic is highly toxic and has been identified by the Agency as a substance which has demonstrated substantial evidence of being carcinogenic. It has also been shown to be mutagenic to bacteria and teratogenic to laboratory animals.

2) Disposal of these wastes in improperly designed or operated landfills has resulted in arsenic contamination of ground and surface water, providing empirical proof that the arsenic in this waste is soluble and may migrate from disposal sites into soil, groundwater and surface water in concentrations sufficient to create a substantial hazard. Further, since arsenic persists in the environment, any contamination caused by mismanagement of these wastes will be long-term.

3) These wastes are generated in large quantities, so that large amounts of arsenic are potentially available for environmental release, an additional hazard posed by this waste.

II. SOURCES OF THE WASTE AND TYPICAL DISPOSAL PRACTICES

A. Profile of the Industry

Three companies produce veterinary pharmaceuticals containing arsenic: Salsbury Laboratories in Charles City, Iowa; Whitmoyer Laboratories in Meyerstown, Pennsylvania; and Fleming Laboratories in Charlotte, North Carolina.[1,2]

B. Manufacturing Process and Waste Generation

Manufacture of arsenic-containing pharmaceuticals requires the reaction of an organic compound with inorganic arsenic to form the organic arsenical product. Arsenic-containing solid wastes generated during the production process include tars from the distillation of aniline-based compounds, and residue from the use of activated carbon in the decolorization of pharmaceuticals.[4] Whitmoyer

reported that it generates these wastes in annual quantities of 100 55-gallon drums and 630 55-gallon drums, respectively.(4) Salsbury Labs also generates arsenic-containing tars from production processes.(5)

Production of veterinary pharmaceuticals from arsenic compounds generates wastewaters which contain organic and inorganic arsenic. Treatment of these wastewaters produce arsenic-bearing sludges. Figure 1 summarizes the wastewater treatment system at Salsbury Laboratories, which produces organic arsenicals marketed as feed additives for chickens, turkey and swine.(1) Process wastewaters at Salsbury are segregated into two sewer systems, of which only the second generates a listed hazardous waste. As a point of clarification, the first sewer system (the source of a non-listed waste) carries waste acid washwater (10,000 gallons per day) from the nitration processes; this washwater is neutralized and clarified. These solids are not believed to contain arsenic, and are not listed in this document.*/

The second sewer system --the source of the listed waste-- collects approximately 25,000 to 30,000 gallons per day of arsenic-containing process wastewaters which originate from

*/Generators must still determine, however, whether this waste stream meets any of the characteristics of hazardous waste contained in §§261.21-24 of the regulations.

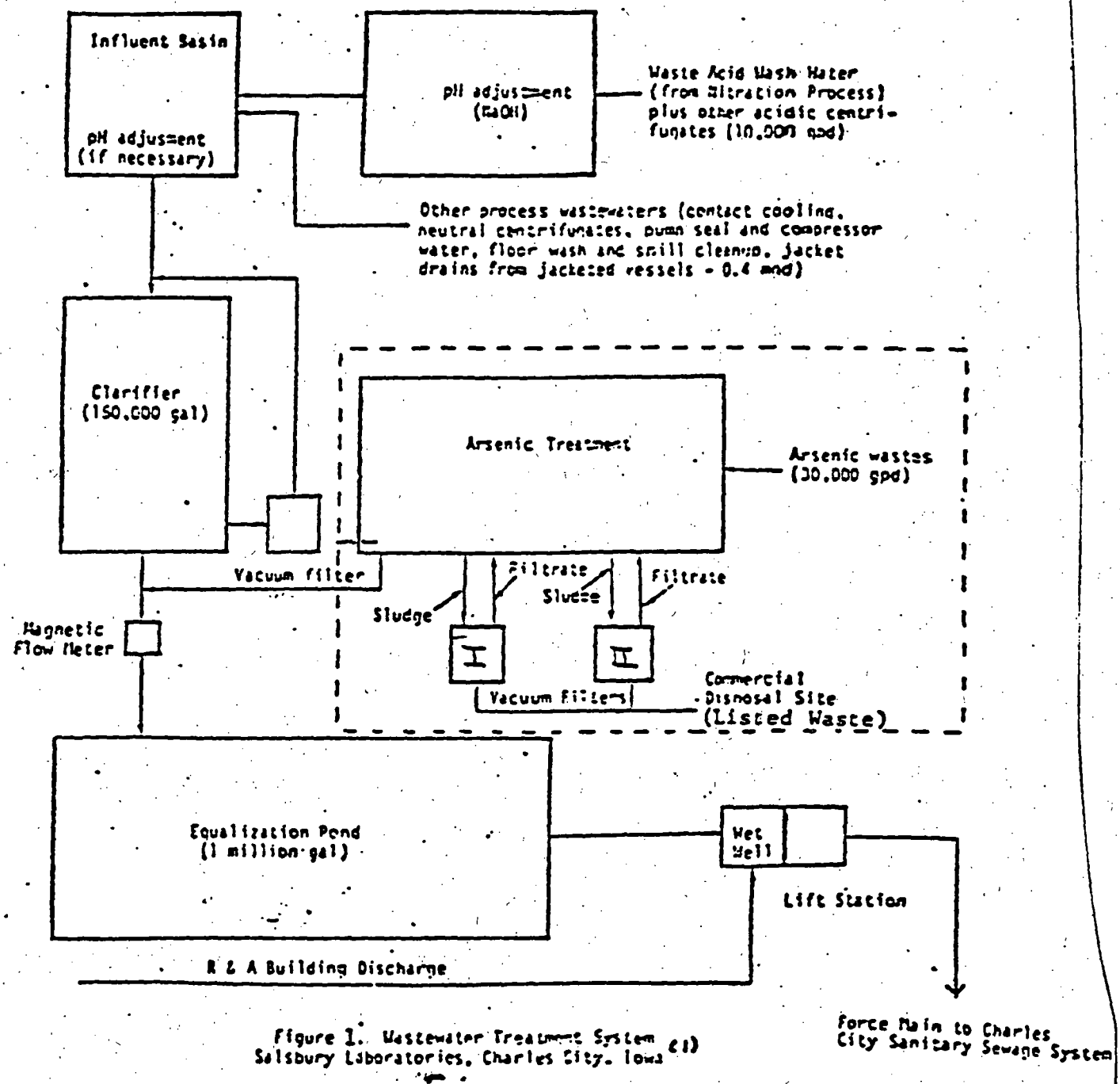

Figure 1. Wastewater Treatment System (1)
Salsbury Laboratories, Charles City, Iowa

the manufacture of Salsbury's arsenical compounds, 3-nitro-4-hydroxyphenylarsonic acid and 4-nitrophenylarsonic acid. The waste treatment process, indicated in Figure 1 by a dashed line, is operated on a batch basis and consists of two parallel systems of treatment basins. The first set of treatment basins works within the box marked "arsenic treatment"; the second set of treatment basins works within the two vacuum filter boxes located below the arsenic treatment box in Figure 1. During "arsenic treatment", slaked lime and a flocculating agent are added to each batch, resulting in pH adjustment to 11.2 - 11.4, and subsequent precipitation of inorganic arsenic. The supernatant liquor is decanted and the precipitate [$Ca_3(AsO_4)_2$ and $Ca_3(AsO_3)_2$] is filtered (vacuum filter box I, Figure 1) on a pre-coated rotary drum vacuum filter. The filtrate and decant liquors are combined and re-introduced into the arsenic treatment box for treatment with $MnSO_4$ and a flocculating agent. The pH is lowered to 7.5 with HCl or H_2SO_4 to form a precipitate which is then drawn off to the second precoated rotary drum vacuum filter (filter box II, Figure 1). The filtrate and decant liquors are mixed with clarifier overflow, which presumably contains no arsenic.

The remaining manufacturers of arsenic-containing veterinary pharmaceuticals also produce arsenic sludges. Whitmoyer Laboratories generates approximately 1,260 drums per year of sludge from the evaporation, volume reduction

and centrifugation of waste salt solutions.[4] Fleming Laboratories reported the production of arsenic sludges, but did not describe the process by which they are generated (24).

The wastewater treatment sludges are believed to contain large amounts of arsenic. A sample of fresh sludge from the Salsbury Laboratories disposal site, the LaBounty landfill, contained 28,000 ppm of arsenic. In addition, the fact that significant concentrations have been released from the waste at the LaBounty site indicates that the contaminant is present in substantial amounts thus, borings from underlying soils exhibited a mean arsenic concentration of 700 ppm and borings from surrounding soils exhibited a mean concentration of 2200 ppm. Samples obtained from a well located between the site and the river showed an arsenic concentration of 590 ppm in groundwater.[1] That these sludges typically contain a large quantity of the contaminant is further supported by a report that Whitmoyer's sludges contain 1-7% arsenic.[4]

Arsenic concentrations in the other listed wastes are also substantial; distillation tars are reported to contain 10-15% arsenic, and residues from activated carbon decolorization contain 4-14% arsenic.[4]

C. Waste Management

From 1953 to December, 1977, Salsbury Laboratories disposed of its solid wastes in the LaBounty Dump, located on the west bank of the Cedar River. (1) Prior to 1953,

solid wastes were disposed of across the river at the municipal dump, but quantities are estimated to be relatively minor compared to those at the LaBounty site. The wastewater treatment sludge presently is stored in drums and shipped by rail to Waste Management, Inc., a commercial disposal operation in Livingston, Alabama.(3)

Whitmoyer Laboratories' treatment sludges were stored in on-site lagoons until groundwater contamination was detected (this was also the disposal practice under prior ownership). Off-site disposal has been utilized since that time. Since 1975, Whitmoyer Laboratories has drummed all of its arsenic-containing wastes, and has shipped these wastes to landfills specially designed to impede release of hazardous constituents to the environment.(4)

III. DISCUSSION OF BASIS FOR LISTING

A. Hazards Posed by the Waste

These treatment sludges, distillation tars, and activated carbon residues contain high concentrations of arsenic, an extremely toxic substance. Arsenic and arsenic compounds have been identified by the Agency as a substance which has demonstrated substantial evidence of carcinogenicity. Arsenic is mutagenic to bacteria and teratogenic to laboratory animals. See Appendix A for further information.

It is quite obvious that improper management of these wastes can result in substantial hazard, since substantial harm has in fact occurred from their faulty management. The

most notorious example of this damage caused by mismanagement of this waste at the LaBounty landfill.

Various wastes, including large amounts of arsenic sludges, were disposed of at the LaBounty site. In January, 1978 approximately 7.5 cubic meters of arsenic sludge were disposed per day. (1) At one time it was estimated that the site contained more than six million pounds of arsenic[1]. The site is located over a major aquifer. As noted above, substantial arsenic contamination of soil and groundwater resulted when the arsenic compounds leached from the waste site. As a result of surface run-off and groundwater discharge, the Cedar River picked up an average load of 53 kg of arsenic per day in the vicinity of the LaBounty Site.(1) The Iowa Department of Environmental Quality issued an order that required Salsbury to cease disposal of wastes at the LaBounty landfill. (77-DQ-01, Dec. 14, 1977).

A report on this damage incident concluded that arsenic in the wastewater treatment sludge is "fairly easily solubilized even if it is precipitated with calcium as the arsenate ($Ca_3(AsO_4)_2$)".[5] The presence of arsenic in ground and surface waters in the vicinity of the LaBounty Site likewise clearly indicates that, once released from the waste, it is highly mobile and persistent.

The migratory potential of the arsenic contained in these wastes is also substantiated by the groundwater

contamination resulting from the storage of the listed waste and similar wastes by Whitmoyer Laboratories in holding lagoons (4). When the groundwater contamination was discovered in the late 1960's, the company began disposing of the sludges at a number of different sites; presently, these wastes are transported by truck to hazardous waste landfills or a specially designed vault disposal operation (4). Again, this demonstrates the potential hazard posed by the migration of waste constituents from a disposal site and the generator's subsequent recognition of this hazard.

An additional demonstration of the necessity for proper management occurred when Salsbury Laboratories, as a result of a cease order, began disposing of solid wastes in a temporary on-site holding basin.(1) This disposal method was quickly terminated because leachate was detected in the underdrain system within 24-hours after disposal.(1) The 1977 court action, coupled with the present management of these wastes in chemical waste landfills, substantiates the concern by both the state and the generator for the proper management and disposal of this hazardous waste.

These damage incidents show that arsenic may easily migrate from these wastes and persist in the environment upon release. Indeed, because arsenic is an element, and does not degrade with the passage of time, it will persist in some form virtually indefinitely.

There are a number of additional reasons to impose hazardous waste status on this waste. Unregulated transpor-

tation of this waste to off-site disposal facilities also increases the likelihood of harmful exposure to human beings and the environment. Without proper means to track the waste from the point of generation to its ultimate destination, the waste might not reach its designated destination at all, thus making it available to do harm elsewhere.

Furthermore, as previously indicated, arsenic sludges from the production of veterinary pharmaceuticals are generated in very substantial quantitites (in January 1978, approximately 7.5 m^3/day at Salsbury plant (1)). Large amounts of arsenic are thus available for potential environmental release. The large quantities of this contaminant pose the danger of polluting large areas of ground or surface waters. Contamination could also occur for long periods of time, since large amounts of this pollutant are available for environmental loading. Attenuative capacity of the environment surrounding the disposal facility could also be reduced or exhausted due to the large quantities of pollutant available. All of these considerations increase the possibility of exposure to this harmful constituent.

B. Health and Ecological Effects

Health Effects

Arsenic is very acutely toxic to animals and humans (6). Death in humans has occurred following ingestion of very small amounts (5mg/kg) (7). Several epidemiological studies have associated cancers with occupational exposure

to arsenic (8-10), including those of the lung, lymphatics and blood (11,12). Skin cancer has been associated with the presence of arsenic in drinking water (13), while liver cancer has developed in several cases following ingestion of arsenic (14). The human carcinogenic potential of arsenic is supported by animal studies.

Occupational exposure to arsenic has also resulted in chromosomal damage (15), and several different arsenic compounds have demonstrated positive mutagenic effects in laboratory studies (16-18). The teratogenicity of arsenic and arsenic compounds is well established (19-21); observed defects include those of the skull, brain, kidneys, gonads, eyes, ribs and genitourinary system.

The effects of chronic arsenic exposure include skin diseases progressing to gangrene, liver damage, neurological disturbances (22), disturbances in red blood cell production and cardiovascular disease (8).

Additional information and specific reference on adverse effects of arsenic can be found in Appendix A.

Ecological Effects

The data base for the toxicity of arsenic to aquatic organisms is more complete for freshwater organisms; concentrations as low as 128 ug/l are acutely toxic to freshwater fish. Based on one chronic life cycle test using *Daphnia magna*, a chronic value for arsenic was estimated at 853 ug/l (21).

Regulatory Recognition of Hazard

OSHA has set a standard 8-hr air TWA in air of 0.5 mg/m^3 for occupational arsenic exposure. 0.05 mg/m^3 has been proposed for arsenic trioxide (23). DOT requires a "poison" warning label.

EPA's Office of Toxic Substances under FIFRA has issued a pre-RPAR. The Carcinogen Assessment Group has identified arsenic and its compounds as a substance which has demonstrated substantial evidence of being carcinogenic. Arsenic is designated as a priority pollutant under Section 307(a) of the CWA. The Office of Drinking Water has regulated arsenic under the Safe Drinking Water Act and the Office of Air Quality Planning and Standards has begun a preregulatory assessment of arsenic based on its suspected carcinogenic effects. The Office of Water Planning and Standards under Section 304 (a) of the Clean Water Act has begun development of a regulation based on health effects other than oncogenicity and environmental effects. Finally, the Office of Toxic Substances has completed Phase I assessment of arsenic under the Toxic Substances Control Act.

Industrial Recognition of Hazard

Arsenic is rated as highly toxic through intra-muscular and subcutaneous route in Sax, Dangerous Properties of Industrial Materials (22). Arsenic is rated as highly toxic through ingestion, inhalation, and percutaneous routes in

Patty, Industrial Hygiene and Toxicology.

A ten-fold reduction (to 0-.05 mg/m^3) of the present OSHA standard for arsenic trioxide has been proposed (23).

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Coking

LISTING BACKGROUND DOCUMENT

COKING

Decanter Tank Tar-Sludge*(T)

I. Summary of Basis for Listing

The spray cooling of coke oven gases during the by-product recovery process results in the generation of a decanter tank tar-sludge. The Administrator has determined that decanter tank tar-sludge may pose a present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1) The tank tar-sludge contains significant concentrations of phenol and naphthalene. Phenol is highly toxic, and an animal carcinogen. Naphthalene is also toxic and is a demonstrated neoplastic substance in experiments done on laboratory animals.

2) Phenol has leached in significant concentration from a waste sample tested in a distilled water extraction procedure. Although no leachate data is currently available for naphthalene, the Agency believes that, due to its presence in the tar in high concentrations and due to its relative solubility, naphthalene also may leach from the waste in harmful concentrations if the waste is improperly managed.

3) These tar-sludges are often land disposed in on-site landfills or dumped in the open. These methods may be inadequate to impede leachate migration and resulting groundwater contamination.

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*The listing description has been amended from that originally proposed on December 18, 1978 (43 FR 58959) which included two waste listings [i.e., Coking: Decanter tank tar and Coking: Decanter tank pitch/sludge]

II. Waste Generation, Composition and Management

Coke, the residue from the destructive distillation of coal, serves as both a fuel and as a reducing agent in the making of iron and steel. Some coke plants recover by-products given off or created during the coke production process, and the recovery of by-products generates the sludge which is listed in this document. There are 66 by-product coke plants, which generate an estimated 72,300 tons/yr of decanter tank tar-sludge. During the recovery of chemicals in the by-product coke production process, tar separates by condensation from coke oven gas and drains to a decanter tank. Recoverable oil fractions are decanted off the top and the tar sludge settles to the bottom.

Approximately 97% of this tar-sludge is elemental carbon. The remaining 3% consists of condensed tar materials. These condensed tar materials contain the waste constituents of concern, namely phenolic compounds and naphthalene, which are formed as a result of the destructive distillation of coal.

Based on a published reference, the condensed tar component contains, by weight, 2.2% naphthalene and 0.1% phenolic compounds(2). With an estimated 2,169 tons/yr of condensed tar contained in the amount of tar-sludge generated annually (i.e., 3% of the 72,300 tons/yr of tar-sludge), approximately 47.7 tons of naphthalene and 2.2 tons of phenolic compounds will be contained in the waste generated each year(1,2).

Of the 66 coke plants generating decanter tank tar-sludge, 30 plants use the tar-sludge as a raw material in either the sintering process or open hearth furnace operation. The remaining 36 plants dispose of this waste in unsecure on-site landfills[1], or by dumping in the open[3].

III. Hazardous Properties of the Waste

Phenol and naphthalene are present in the tar component of this waste in significant concentrations: 0.1% by weight (1000 ppm) and 2.2% by weight (22,000 ppm), respectively[2]. Phenol is highly toxic and is also an animal carcinogen, while naphthalene is toxic. Thus, the Agency believes that the concentrations of these materials in the waste are quite significant, in light of the constituents' known health hazards. Further, these waste constituents appear capable of migrating in significant concentrations if mismanaged, and are likely to be mobile and persistent so that waste mismanagement could result in a substantial human health or environmental hazard.

Phenol's potential for migration from this waste in significant concentrations has been demonstrated empirically. Phenol leached in significant concentration (approximately 500 ppm) from a decanter tar-sludge waste sample subjected to distilled water extraction procedure.[3] In addition, phenol is extremely soluble, about 67,000 ppm @ 25°C[5], indicating high potential for migration. Phenol biodegrades at a moderate rate in surface water and soil but moves very

readily (App. B). Even with a persistence of only a few day, the rapid spreading of phenol could cause widespread contamination of the eco-system and contamination of potable water supplies.

The migratory potential of phenol and its ability to move through soils is further confirmed by the fact that it has been detected migrating from Hooker Corporation's S Area, Hyde Park, and 102nd St. landfills in Niagara, New York (OSW Hazardous Waste Division, Hazardous Waste Incidents, Open File, 1978). The compound's persistence following migration is likewise shown by these incidents.

Although no comparable leachate data is currently available for naphthalene, the Agency believes that this constituent also may leach in harmful concentrations from the waste if not properly managed. Naphthalene is very water soluble, with solubilities ranging from 30,000 ug/l to 40,000 ug/l. In addition, naphthalene has been identified in finished drinking water, lakes, and rivers, demonstrating its ability to persist and to be mobile[4]. This information, naphthalene's solubility in water, and its presence in the tar in such high concentrations (22,000 ppm) make it likely that it will leach from the waste in potentially harmful concentrations if the waste is mismanaged, and will then be mobile and persistent, and so poses the potential for causing substantial hazard to human health and the environment.

Current practices of disposing of this waste in fact appear inadequate. Disposal of decanter tank tar-sludge in unsecured landfills or by dumping in the open makes it likely

that the hazardous constituents in the waste will leach out and migrate into the environment, possibly reaching and contaminating drinking water sources. Siting of waste management facilities in areas with highly permeable soils could facilitate leachate migration. As demonstrated above, the waste constituents appear capable of migration, mobility and persistence. Thus, if disposal sites are improperly managed or designed (e.g., lack adequate leachate collection systems), waste constituents could leach into soils and contaminate groundwater.

Health and Ecological Effects

Phenol

Congress designated phenol a priority pollutant under §307(a) of the Clean Water Act.

Phenol is readily absorbed by all routes. It is rapidly distributed to mammalian tissues. This is illustrated by the fact that acutely toxic doses of phenol can produce symptoms within minutes of administration regardless of the route of entry. Repeated exposures to phenol at high concentrations have resulted in chronic liver damage in humans.(3) Chronic poisoning, following prolonged exposures to low concentrations of the vapor or mist, results in digestive disturbances (vomiting, difficulty in swallowing, excessive salivation, diarrhea), nervous disorders (headache, fainting, dizziness, mental disturbances), and skin eruptions(4). Chronic poisoning may terminate fatally in some cases where

there has been extensive damage to the kidneys or liver.

OSHA has set a TLV for phenol at 5 ppm. Phenol is listed in Sax's Dangerous Properties of Industrial Materials as highly toxic via an oral route.[4] Sax also describes phenol as a co-carcinogen and a demonstrated carcinogen via a dermal route in studies done with laboratory animals. Additional information and specific references on the adverse effects of phenol can be found in Appendix A.

Naphthalene

Naphthalene is designated as a priority pollutant under Section 307(a) of the CWA.

Systemic reaction to acute exposure to naphthalene includes nausea, headache, diaphoresis, hematuria, fever, anemia, liver damage, convulsions and coma. Industrial exposure to naphthalene appears to cause increased incidence of cataracts. Also, hemolytic anemia with associated jaundice and occasionally renal disease from precipitated hemoglobin has been described in newborn infants, children, and adults after exposure to naphthalene by ingestion, inhalation, or possibly by skin contact.

OSHA's standard for exposure to vapor for a time-weighted industrial exposure is 50 mg/m^3.

Sax lists naphthalene as moderately toxic via the oral route and warns that naphthalene is a demonstrated neoplastic substance via the subcutaneous route in experiments done on

laboratory animals[4]. Additional information and specific references on the adverse effects of naphthalene can be found in Appendix A.

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Primary Metals

LISTING BACKGROUND DOCUMENT

PRIMARY ALUMINUM REDUCTION

Spent potliners from primary aluminum reduction (T)

I. SUMMARY OF BASIS FOR LISTING

Primary aluminum metal is produced by the electrolytic reduction of alumina, an aluminum oxide. This process takes place in carbon-lined cast iron electrolytic cells known as "pots". After continued use, the carbon pot lining ("pot-liner") cracks, and must be removed and replaced with a new potliner.

The Administrator has determined that these used potliners ("spent potliners") are a solid waste which may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and, therefore, should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1. Spent potliners from primary aluminum reduction contain significant amounts of iron cyanide complexes. EPA has detected iron cyanide complexes (expressed as cyanides) in spent potliners in significant concentrations.

Note: The Agency is aware that there are other solid wastes generated by the primary aluminum reduction process, and is currently investigating these wastes to determine whether to list them as hazardous in the future.

2. The aluminum reduction industry typically either stores spent potliners in unprotected piles outside (prior to reprocessing) or dumps them in the open. Part or all or the cyanide contained in the spent potliners can be expected to be released into the environment if spent potliners are dumped in the open, stored without protection in the open or otherwise improperly managed. Available data indicates that significant amounts of free cyanide and iron cyanide will leach from potliners if the spent potliners are stored or disposed of in unprotected piles out-of-doors and exposed to rainwater. In addition, in the presence of sunlight, the iron cyanides may decompose to release highly toxic hydrogen cyanide into the environment. Iron cyanide complexes are toxic and free cyanide is extremely toxic to both humans and aquatic life if ingested.

3. One major damage incident has been reported which is attributable to the improper disposal of spent potliners, demonstrating migration, mobility and persistence of waste constituents, and demonstrating as well that substantial hazard can result from improper management of this waste.

4. In 1977, the primary aluminum reduction industry generated an estimated 191,000 MT of spent potliners per year (approximately 6,366 MT per average-sized plant). This figure is expected to increase to 243,000 MT (approximately 8,100 MT per plant) by 1983. Generation of such large quantities of waste increases the potential for hazard if mismanagment should occur and is a further justification for listing these wastes as hazardous.

II. SOURCES OF THE WASTE AND TYPICAL DISPOSAL PRACTICES

A. Profile of the Aluminum Reduction Industry

Primary aluminum plants convert aluminum oxides into aluminum metal. Currently, there are 30* primary aluminum plants, located in 16 states, operating in the United States.

The primary aluminum industry currently produces approximately 5 million MT of primary aluminum per year (100,000 to 150,000 tons per year for an average-size plant). Pro-

*One other plant operates on a stand-by basis.

duction has been increasing for many years and is expected to reach 7 million MT per year by 1985.(7)

B. Manufacturing Process

Aluminum metal is produced almost entirely by the Hall-Heroult process. In this process, alumina, an aluminum oxide is reduced to aluminum metal in carbon-lined cast iron electrolytic cells known as "pots". The carbon potlining ("potliner") acts as the cathode of the cell; petroleum coke and pitch act as the anode; and cryolite, calcium fluoride, and aluminum fluoride are used as the electrolyte. When an electric current is passed through the pots, the alumina is reduced to aluminum metal. The molten aluminum is periodically drawn off as it accumulates in the bottom of the pots.

During the reduction process, iron cyanide complexes form in the potliners. The chemical/physical mechanism by which these compounds are produced is poorly understood(4); however, it is generally agreed that the iron cyanide compounds are produced in all cases(7).

C. Waste Genration and Management

After continued use, potliners crack, causing the molten aluminum in the pots to become contaminated with iron from the cast iron pots. At this point, the cracked potliners ("spent potliners") must be removed from the pots and replaced with new carbon potliners(1).

In 1974, the primary aluminum industry generated approximately 159,000 MT of spent potliners (approximately 5,300 MT for an average sized plant). By 1977, the industry

was generating an estimated 191,000 MT of spent potliners per year (6,366 MT per average facility)(1). This figure is expected to increase to 243,000 MT by 1983(1).

Spent potliners are either processed to recover cryolite (which saturates the potliners during the reduction process)*/ or disposed of immediately.(1,7) Those spent potliners which are reprocessed are usually stored on-site out-of-doors in uncovered piles(1,3,4,7), sometimes for periods of up to five years or more before reprocessing.(7) Spent potliners which are disposed of immediately are generally dumped in the open, either off-site or on-site.(1,3,4,7) No site preparation other than tree and shrub removal is commonly practiced(7). One company also has been reported to dispose of spent potliners in a lagoon, along with industrial sludge.(7)

D. Hazardous Properties of Spent Potliners

Spent potliners contain iron cyanide complexes. As noted above in Section B, these complexed cyanides are generated during the reduction process, and are believed to be present in all spent potliners. Analyses of leachate from piles of spent potliners (discussed below) confirm the presence of iron cyanide and free cyanide in the spent potliners(2,3,4,5). These concentratins are indicative of a potential for hazard, since these complexed cyanides are capable of migration as highly toxic free cyanides. Furthermore, iron cyanides themselves are toxic.

*/The Agency has information indicating that the wastewater from the cryolite recovery process contains high concentrations of cyanide. This waste stream is, therefore, being considered by the Agency as a candidate for future listing. Further information is solicited.

The following discussion demonstrates that cyanides are present in these wastes in substantial concentrations, and that, if the wastes are mismanaged, cyanide may migrate as both free and complexed cyanide, and may be mobile and presistent enough to reach environmental receptors via groundwater, surface water and air exposure pathways in concentrations sufficient to create a substantial hazard. Indeed, one damage incident involving spent potliners confirms that these wastes can cause substantial hazard if mismanaged.

A. Waste Composition and Migratory Potential of Waste Constituents

The Agency does not presently possess reliable data on iron cyanide concentrations in spent potliners themselves, but concludes that the concentrations of cyanide in potliners are substantial, based on cyanide concentrations in leachate from potliners. These data further demonstrate that the iron cyanide in the waste may migrate as highly toxic free cyanide in high concentrations in leachate or surface runoff. Monitoring samples taken by Kaiser Aluminum and Chemical Company in 1976 (10) confirm that free cyanide may migrate from this waste in high concentrations upon exposure to leaching media. These data indicate 2500 mg/l of free cyanide (13,000 mg/l total cyanide) in potlining slab liquor samples (the runoff from concrete slabs on which spent potliners are placed during open storage), and 1200 mg/l free cyanide (9000 mg/l total cyanide) in pot soaking pit liquor sample (liquor

left after spraying pots to facilitate removal of the liner)(10). That these concentrations pose very high potential for hazard is indicated by the fact that exposure to 300 ppm of cyanide will cause death to humans in minutes (see p. 9 below).

Furthermore, in a paper entitled "Development of a Method for Detoxificaiton of Spent Cathode (potliner) Leachates", Comalco Aluminum personnel stated, " The storm water leachate from spent reduction cell cathodes (spent potliners) stored uncovered in the open typically contains unacceptably high levels of cyandies."(4). Table 1 of this paper shows spent potliner leachate to contain 200 mg/l */ of free cyanide and 2000 mg/l complexed cyanides prior to leachate treatment.

A third source likewise identifies substantial concentrations of complexed cyanides in leachate from spent potliners. The Kaiser Aluminum and Chemical Company collected and analyzed samples of pondwater from a pond that collects rainwater runoff from spent potliners which are discarded in a 10-acre dump next to its Chalmette, LA plant. Kaiser reported that pond liquor contains complexed cyanide in concentrations ranging from 50-700 ppm.(3,9) The chemical analyses of the pond liquor samples show concentrations of 100-350 ppm cyanide.(9)

Thus, both extremely toxic free cyanide and less toxic iron cyanides are capable of migrating from spent potliners in

*/The table, in fact, does not give units of measurement, but the actual values indicate that the units are mg/l.

substantial concentrations if the waste is exposed to leaching media. Migration of free cyanides may also occur via an airborne route. Iron cyanide has long been known to undergo photodecomposition leaving extremely toxic hydrogen cyanide and free cyanide decomposition byproducts.(8,13,14,15,16)*/ Hydrogen cyanide will then enter the atmosphere, where it is both mobile and persistent.(17) **/

Once free cyanide migrates from the waste it is likely to be quite mobile in soils. Cyanide has been shown to move through soils into groundwater.(12) Disposal of these wastes in the open, a present waste management method, could therefore lead to release of free cyanides and subsequent migration through soils to groundwater. (Migrating iron cyanide, on the other hand, has limited mobility in soils, but, as shown above, can photolyse to form mobile cyanide and hydrogen cyanide.)

Thus, these wastes may potentially release high concentrations of cyanide into water and (to a lesser extent) air, should mismanagement occur. Current waste management practices appear to allow a strong possibility of migration of cyanide i.e., spent potliners are often simply dumped in the open. Spent potliners being stored for cryolite recovery are also piled in the open without cover, sometimes for periods of up to five years (see p. 4 above). The Agency believes that substantial hazard could result from these

*/These sources do not indicate a degradation rate constant.

**/Hydrogen cyanide is reported to be resistant to naturally occuring wavelengths reaching the earth's surface.(17)

types of waste management practices, in light of this waste's potential to release free cyanide, and cyanide's mobility and persistence following release.

An actual damage incident involving spent potliners confirms this judgement. Kaiser Aluminum's Mead Works is situated 150 feet above the Spokane aquifier which is used for private wells and which drains into the Little Spokane River.(5) Leachate from a lagoon containing potliners and sludge leached through the ground and contaminated the aquifier with cyanide.(5) Eighteen wells were contaminated, some having cyanide levels in excess of 1,000 ppb.(5) Kaiser had to provide alternative sources of drinking water to the affected owners and to upgrade and seal the leaking lagoon.(5)

A further reason for listing spent potliners as hazardous is the quantity of waste generated. Approximately 191,000 MT of spent potliners were generated by the aluminum industry in 1977 and this figure is expected to increase substantially (see p. 3). Thus, large amounts of cyanide are available (in light of the high concentrations in leachate) for environmental release. These large quantities pose the danger of polluting large expanses of ground and surface waters, and an increased likelihood of reaching environmental receptors, in light of cyanide's mobility in water and air. Contamination also could occur for long periods of time, since large amounts of pollutants are available for environmental loading. Attenuative capactiy of the environment

could also be reduced or exhausted by large quantities of pollutants released from the waste. All of these considerations increase the possibility of exposure to harmful constituents in the waste and, in the Agency's point of view, further justify a "T" listing.

Hazards Posed by Harmful Constituents

Cyanide is extremely toxic when it is ingested in free form and less toxic when ingested in complex form. (Appendix A). Free cyanide can cause death in humans and aquatic life. In its most toxic form, cyanide can be fatal to humans in a few minutes at a concentration of 300 ppm. While recovery from non-fatal poisonings is generally rapid and complete, fatal exposure levels are low. (App. A)

The Public Health Service recommends 0.2 mg/l as the acceptable level of cyanide for water supplies and EPA has recommended that this level be used as the ambient water quality standard under the Clean Water Act. The Canadian government has set a similar criterion. OSHA has regulated exposure levels for the workplace. Finally, final or proposed regulations of the states of California, Maine, Maryland, Massachusetts, Minnesota, Missouri, New Mexico and Oregon define cyanide-containing compounds as hazardous waste or components thereof. See Appendix A for references and additional information on cyanide.

Response to Comments

On August 22, 1979, EPA proposed to list spent potliners as a hazardous waste (44 FR 49404). No information was submitted during the public comment period that disagreed with the conclusion that spent potliners are hazardous as defined by the proposed regulation. The Anaconda Company stated however, that the particular disposal practices, coupled with the physical and geologic conditions at its two primary aluminum smelters produce "no significant release of any constitutent from the spent potliners into an underground water supply." (6). Anaconda indicates that coal (not water) underlies its Kentucky disposal site, that there is little rain at its Montana site. It concludes that the standards for each disposal site should be established separately.

The conditions at any particular disposal site do not, however, change the initial determination of whether or not a waste is hazardous. A waste is listed as hazardous if it may pose a substantial threat to human health and the environment if it is mismanaged. Anaconda implicitly concedes that if the constituents released from spent potliners entered a drinking water reservoir, such a threat would exist. The individual circumstances of a particular disposal site will be addressed when a permit is issued, and are other-

wise taken into account in many of the standards contained in the recently promulgated Parts 264 and 265 (see, e.g., §265.90(c), which provides for a waiver of the groundwater monitoring requirement if a facility owner/operator demonstrates "that there is a low potential for migration of hazardous waste or hazardous waste constituents from the facility via the uppermost aquifer to water supply wells ... or to surface water").

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LISTING BACKGROUND DOCUMENT

PRIMARY SMELTING AND REFINING OF FERROALLOYS*

Emission control dust/sludge from ferromanganese (FeMn) production in electric furnaces (T)

Emission control dust/sludge from ferrochromium (FeCr) production in electric furnaces (T)

Emission control dust/sludge from ferrochromium-silicon (FeCrSi) production in electric furnaces (T)

I. Summary of Basis for Listing

The emission control dusts/sludges from the production of ferromanganese, ferrochromium and ferrochromium-silicon are generated when particulates entrained in the reaction gases given off by electric furnaces during the smelting process are removed by air pollution control equipment. Dry collection methods generate dust; wet collection methods result in sludge. The Administrator has determined that these dusts/sludges are solid wastes which may pose a present or potential hazard to human health and the environment when improperly transported, treated, stored, disposed of or otherwise managed and therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1) The emission control dusts/sludges from ferromanganese and ferrochromium production contain significant concentrations of the toxic heavy metals chromium and lead, and emission control dusts/sludges from production of ferrochromium silicon contain significant concentrations of chromium.

*The Agency has recently obtained information indicating that wastes generated by the ferroalloys industry are likely to contain substantial concentrations of polycyclic organic several carcinogenic compounds (5). For this reason, EPA will expand the listing for the ferroalloys industry if further studies show that such wastes pose a hazard to human health and the environment.

2) Significant concentrations of chromium and lead have been shown to leach from various samples of ferromanganese and ferrochromium wastes subjected to extraction procedures, while significant concentrations of chromium have been shown to leach from samples of ferrochromium/silicon waste subjected to the same extraction procedures.

3) A large quantity (a combined total of approximately 120,000 tons) of these wastes is generated annually. There is thus a risk of large scale contamination of the environment if the wastes are mismanaged. Lead and chromium persist virtually indefinitely in the environment, posing the further threat of long-term contamination.

4) The wastes typically are disposed of by dumping in the open, in landfills or in unlined lagoons. Thus, the possibility exists for the migration in harmful concentrations of lead and chromium to groundwater or surface water.

II. Sources of the Waste and Typical Disposal Practices

A. Industry Profile and Manufacturing Process

The ferroalloys industry produces a variety of ferroalloys for use in the manufacture of iron, steel and non-ferrous metals (1). In May, 1980, eight companies produced ferrochromium, ferrochromium-silicon or ferromanganese in electric furnaces. Those producers are listed in Table 1 (5). It should be noted that companies may frequently change their product lines and put furnaces in or out of service according to product demand or operating requirements.

Ferrochromium, ferrochromium-silicon and ferromanganese are generally produced by carbothermal smelting in electric submerged-arc furnaces (some ferromanganese is also produced in blast furnaces). The raw materials used most often include

Table 1 - Producers of FeMn, FeCr or FeCrSi in in the United States May, 1980 (5)

Producer	Products
CHROMASCO Woodstock, TN.	FeCr
INTERLAKE Beverly, OH.	FeCrSi, FeCr
MACALLOY Charleston, SC	FeCr
OHIO FERROALLOYS Philo, OH.	FeMn
SAMANCOR Rockwood, TN.	FeMn
SATRALLOY Steubenville, OH.	FeCr, FeCrSi
SKW ALLOYS Calvert City, KY. Niagara Falls, NY.	 FeMn FeCrSi
UNION CARBIDE Marietta, OH. Portland, OR.	 FeMn, FrCr FeMn

mineral ores and concentrates of manganese, chromium and silicon, steel turnings and reducing agents such as coke, coal and wood chips (2). Feed materials are charged to the furnace on either a continuous or intermittent basis. The molten alloy collects at the bottom of the furnace and is removed to a cooling area.

B. Waste Generation

The process of reducing metallic ores to a metallic state generates large quantities of carbon monoxide along with other gases from moisture in the charge materials, reducing agent volatile matter, thermal decomposition products of the raw ore and intermediate products of the reaction (1). The gases carry fumes from the high temperature regions of the furnace and entrain fine particles of the charge materials. Particulate matter, which contains lead and chromium originally present in the charge materials, is removed from the gases by baghouse collection systems, electrostatic precipitators, or scrubbers. Wastes are collected from baghouses and precipitators as dusts and from scrubbers as sludges (2). These emission control dusts/sludges are the waste streams of concern. The Ferroalloys Association estimates that approximately 120,000 tons of these wastes are generated annually (2).

C. Current Disposal Practices

Dusts typically are dumped directly on land or disposed of in landfills (2,3). Dusts from the production of different

ferralloys are generally mixed and disposed of together. (Comments of the Ferroalloys Association, January 9, 1979.) Sludges usually are sent to unlined lagoons for settling; the sediments are dredged periodically and dumped on land (3). Waste piles in disposal areas can approach 250 feet in places, and the depth of disposal lagoons may approach 25 feet (2).

III. Hazardous Properties of the Waste

Ferroalloy production emission control dusts and sludges consist primarily of sub-micron particles composed of oxides of various elements, including lead and chromium (3). The Agency has data from two sources which indicate that substantial amounts of lead and chromium are contained in ferromanganese and ferrochromium dusts/sludges, while dusts and sludges from ferrochromium-silicon production contain substantial concentrations of chromium. The data are presented in Tables 2 and 3.

Table 2. Concentrations of Lead and Chromium in Ferroalloys Dusts/Sludges (3).

Product	Sample Source	Cr(ppm)	Pb(ppm)
Ferromanganese	Baghouse (dust)	32	6000
	Scrubber (sludge)	18	5000
Ferrochromium	Electrostatic precipitator (dust)	3,390	300
Ferrochromium-silicon	Baghouse (dust)	41	--

Table 3. Concentrations of Lead and Chromium in Particulate Matter Generated During Production of Ferroalloys† (1).

Product	Sample Source	Cr(ppm)	Pb(ppm)
Ferromanganese	Scrubber stack outlet	<80	1,130
Ferrochromium	Furnace	140,000	--
	Electrostatic precipitator (dust)	40,000	1,000
Ferrochromium-silicon	Furnace	14,100	<10
	Baghouse inlet	4,400	--

†Most of the samples are of particulate matter collected from the furnace emissions prior to cleaning in an air pollution control device. These samples should be similar to the dust or sludge generated by these types of furnaces since emission control equipment removes 95-99% of these contaminants prior to air emission. (Comments of Ferroalloys Association, June 7, 1977, App. B.) The sample of particulate matter from the FeMn scrubber stack outlet should indicate which pollutant species are present in the sludge or dust, although relative quantities may be different from those in the solid waste.

Simulated leaching data also indicate that lead and chromium are capable of leaching from these wastes in concentrations sufficient to create a potential for substantial hazard. Table 6 below shows distilled water and acetic acid extraction data supplied by the Ferroalloys Association for selected emission control dusts. In most cases, contaminant levels in leachate are one to two orders of magnitude in excess of drinking water standards.

The Agency also has extraction data showing high concentrations of the constituents of concern in a distilled water extract of the waste:

Table 6 - Waste Extraction Data for Ferroalloys Waste (2)

Waste from FeMn Production	Drinking Water Standard	Extract Concentrations	
EPA EP Using H_2O		Cr	Pb
Emissions Control Dust (Sx #1)	.05	1.4	2.0
Emissions Control Dust (Sx #2)		1.0	7.6
EPA EP per 9/12/78 Draft (Acetic Acid Extractant)			
Emissions Control Dust		.40	14.0
Waste from FeCr Production			
EPA EP Using H_2O			
Emissions Control Dust (Sx #1)		.65	<.10
Scrubber Dust (Sx #2)		<.10	<.10
EPA EP per 9-12-78 Draft (Acetic Acid Extractant)			
Scrubber Dust (Sx #2)		<.10	<.10
Waste from FeCrSi Production			
EPA EP Using H_2O Only			
Emissions Control Dust		2.0	<.10
EPA EP per 9-12-78 Draft (Acetic Acid Extractant)			
Emissions Control/Dust		2.4	.30

Source: Comment of the Ferroalloys Association, January 9, 1979.

Table 7 (3)

Product	Sample	ppm in distilled water extract Cr	Pb
FeMn	Baghouse dust	0.2	560
FeCr	ESP dust	710	0.7
FeCrSi	Baghouse dust	190	1.5

The Agency frankly entertains some doubts as to the probity of the data in Table 7. For example, the chromium value for the FeCrSi baghouse dust waste extract exceeds the value given for the raw waste sample in Table 2 above (which was obtained during the same study.) Such a discrepancy can only be attributable to an error in the calculation or in the recording of data, or to the use of faulty analytical techniques. Since high concentrations (14,000 and 4,400 ppm) of chromium in the particulate matter given off during the production of ferrochromium-silicon are reported in Table 3, the Agency believes it likely that the 41 ppm chromium value shown in Table 2 is grossly understated. In any case, the Agency views this data, while hardly determinative, as at least corroborative of other data submitted by industry showing waste constituents capable of migration in potentially harmful concentrations.

Furthermore, groundwater monitoring performed by an independent laboratory for the Ferroalloys Association

indicates that lead, one of the two waste constituents of concern, can migrate from ferroalloy waste disposal sites and reach groundwater in harmful concentrations. Thus, groundwater monitoring in the vicinity of an "unlined disposal lagoon" on the site of an unidentified ferroalloy company revealed lead concentrations in groundwater exceeding the National Interim Primary Drinking Water Standard of .05 mg/l, as shown in Table 4. In the second test, apparently only one well was measured; no contamination was detected.

Table 4 - Monitoring Data From Groundwater Wells Surrounding An Unlined Disposal Lagoon Showing Lead Concentrations In Groundwater (Reference: Comments of Ferroalloys Association, June 29, 1979.)

Monitoring Location	Distance from Lagoons,(Ft.)	Pb Concentration(mg/l)
Test #1		
Lagoon Analysis	---	.03
#1 Well	100	.085
#2 Well	500	.105
#3 Well	200	.190
#4 Well	100	.085
#4 Well	1600	.090
Test #2		
Lagoon Analysis	---	.160
#8 Well	375	----

Without groundwater background monitoring data, it cannot be said with assurance that the disposal lagoon is the source of lead contamination. However, the comments do not indicate any other source of contamination, and the fact that monitored lead levels in groundwater levels appreciably exceeded levels in the lagoon could indicate that concentrated solids from the lagoon are leaching into groundwater.* Certainly, this data fails to support the Ferroalloys Association's claim that of an absence of environmental problems from current disposal practice. (Comments of Ferroalloys Association, June 29, 1979, p.3).

Ferroalloys Association also supplied monitering data obtained from wells in the vicinity of a ferroalloy waste landfill (2). These data are shown in Table 5.

Although the monitoring results might indicate that this landfill does not contribute substantially to groundwater contamination (measurements from wells located downgradient from the landfill are similar to background levels), the Agency is unable to determine whether this is a valid interpretation of the data without considerably more information on the hydrogeological characteristics of the site, the placement, construction and operation of the monitoring wells, the types and compositions of the wastes in the landfill and the protocols utilized to obtain and analyze the groundwater samples. Sampling over a longer period is probably

*Thus, the unexplained "lagoon analysis" could be of liquid in the lagoon rather than settled solids.

Table 5 - Monitoring Data from Groundwater Wells Surrounding a "Typical Landfill" Showing Lead Concentrations in Groundwater

Location Test	Pb in Groundwater (mg/l)
Test #1	
Upgradient Groundwater Background	
Well #3	<.03
Well #4	.08
Downgradient of Landfill	
Well #1	.08
Well #2	.06
Well #5	.03
Test #2 (1 month after #1)	
Upgradient	
Well #3	.07
Well #4	.05
Downgradient	
Well #1	.08
Well #2	.10
Well #5	<.03
Test #3 (2 months after #1)	
Upgradient	**Pb in Groundwater (mg/l)**
Well #3	.08
Well #4	.08
Downgradient	
Well #1	.05
Well #2	.03
Well #5	.04

Note: Chromium was also monitored at these locations (although not at the wells surrounding the lagoon in Table 4), but chromium concentrations did not exceed the National Interim Primary Drinking Water Standard.

also necessary. Based on the information provided, the Agency can only observe that lead concentrations in groundwater in the vicinity of this landfill frequently exceed the National Interim Primary Drinking Water Standard of 0.05 mg/l. Therefore a potential hazard appears to exist unless proper management of these wastes is assured.*

It should be noted that some of the wastes included in this listing may not fail the toxicity characteristic (even though leachate data indicates that lead and chromium in these wastes have substantial migratory potential). This does not preclude listing of the wastes. The Agency believes that there are factors in addition to metal concentrations in leachate which justify this listing. As indicated above, these wastes are generated in very substantial quantities and may contain high concentrations of lead and chromium. Industry data indicate that groundwater contamination from ferroalloy waste disposal may already have occurred. In addition, large amounts of these metals are available for potential environmental release. The large quantities of these contaminants pose the danger of polluting large areas of ground or surface waters if waste mismanagement occurs. Contamination could also occur over long periods of time since large amounts of pollutants, which, as heavy metals, persist virtually indefinitely, are available for environmental release. Attenuative capacity

* The Ferroalloys Association indicated that the waste dusts are believed to exhibit sealant properties when wetted, thereby reducing leaching. This data (particularly that in Table 4), however, suggests that any sealant properties of the waste are insufficient to prevent waste constituent migration.

of the environment surrounding the disposal facility could also be reduced or exhausted due to the large quantities of pollutants available.

Furthermore, current management practices may not be adequate to prevent leachate migration and subsequent groundwater and/or surface water contamination. Industry submissions indicate that disposal lagoons and landfills are generally unlined, and that no special steps are taken to impede leachate formation (although the dusts are reported to exhibit a sealant effect when wetted, this appears insufficient to prevent leachate formation and migration). As a result, these waste management practices may have the potential to allow release of harmful concentrations of contained toxicants, particularly if disposal occurs in areas with highly permeable soils, or where waste is directly exposed to groundwater due to the height of the water table. If wastes are disposed of where acid rain is prevalent, solubilization of toxic heavy metals is even more likely to occur. Uncontrolled surface run-off from the waste piles and overflow from lagoons might disperse the wastes and/or their toxic constituents in the surrounding area. If control practices are nonexistent or inadequate, contaminant-bearing leachate, run-off or impoundment overflow may reach ground and surface waters, polluting valuable drinking water supplies.

IV. Hazards Associated With Constituents of Concern

Ingestion of drinking water from ground and surface waters contaminated by lead and chromium threatens human

health; aquatic species exposed to the heavy metals may also be adversely effected. Chromium is toxic to man and lower forms of aquatic life. Lead is poisonous in all forms, and is one of the most hazardous of the toxic metals because it bioaccumulates in many organisms.

The hazards of human exposure to lead include neurological damage, renal damage and adverse reproductive effects. In addition, lead is carcinogenic to laboratory animals and relatively toxic to freshwater organisms. (see Appendix A) It also bioaccumulates in many species.

Contact with chromium compounds can cause dermal ulceration in humans. Data also indicate that there may be a correlation between worker exposure to chromium and development of hepatic lesions. Additional information on the adverse health effects of these elements can be found in Appendix A.

The hazards associated with lead and chromium-containing compounds have been recognized by other regulatory programs. Lead and chromium are listed as priority pollutants in accordance with §307 of the Clean Water Act, and National Interim Primary Drinking Water Standards have been established pursuant to the Safe Drinking Water Act. The Occupational Health and Safety Administration has a final standard for occupational exposure to lead and a draft technical standard for occupational exposure to chromium. In addition, a national ambient air quality standard for lead has been announced

under the Clean Air Act. Final or proposed regulations of the States of California, Maine, Massachusetts, Minnesota, Missouri, New Mexico, Oklahoma and Oregon define lead and chromium compounds as hazardous wastes or components of hazardous wastes (4).

References

1. Dealy, James O., and A. M. Killin. Engineering and Cost Study of the Ferroalloy Industry. EPA-450/2-74-008, May, 1974.

2. U.S. EPA, RCRA Section 3001 Docket, Attachment to Communication from George A. Watson to Claire Welty, June 29, 1979.

3. U.S. EPA, Office of Solid Waste. Assessment of Hazardous Waste Practices in the Metal Smelting and Refining Industry. Calspan Corporation. EPA Contract No. 68-01-2604, April, 1977. Volumes III and IV.

4. U.S. EPA States Regulations Files, January 1980.

5. Westbrook, C.W. and D.P. Daugherty. Environmental Assessment of Electric Submerged Arc Furnaces for Production of Ferroalloys (DRAFT). USEPA, RTI/1434/04-02f, March 1980.

Comments and Responses

- One comment stated that ferrochromium-silicon emission control dusts/sludges should not be listed because a discrepancy between the chromium concentrations reported in the original sample and the extract of that sample exists; 190 ppm were found in leachate but only 41 ppm in the original waste sample.

The Agency agrees that an error was made. The error might be due to faulty analytical techniques or to a mistake in calculating or recording data. As stated in the background document, however, data from another source indicates that chromium concentrations in ferrochromium silicon emission control dusts/sludges might be much higher. For this reason, EPA believes that the value of 41 ppm is understated and will continue to list this waste as hazardous.

- The Ferroalloys Association stated that the extracts of ferroalloys emission control dusts/sludges which they obtained by performing the proposed extraction procedure were only slightly above the limits defined as hazardous in the proposed regulations and therefore the wastes should not be classified as hazardous.

It is unusual that the data supplied by the Ferroalloys Association shows significantly less leaching using the proposed Extraction Procedure than other data from a distilled water extraction since the EP is the more rigorous of the two methods. Because such large quantities of these wastes are generated and samples of the wastes leached chromium in excess of 100 times the National Interim Primary Drinking Water Standard when subjected to a distilled water extraction, the Agency has decided that the wastes pose a potential threat to

human health and the environment and therefore should remain on the hazardous waste list.

- o One comment indicated that the wastes are not hazardous because they are properly managed.

The purpose of the regulations developed pursuant to §3001 of RCRA is to define hazardous waste. The hazard posed by a waste due to potential mismanagement is only one factor in the determination that a waste should be listed as hazardous. Other factors such as the nature of the hazard must be considered. The Agency believes that the waste listed above contain significant amounts of lead and chromium which may leach from the waste matrix and migrate to ground and surface waters; therefore the waste poses a threat to human health and the environment.

- o One comment included ground water monitoring data which show that the hazardous constituents of the waste do not migrate from the waste.

The data were acquired over a short period of time (2 months) and may not be representative of contaminant migration over a period of years. In addition, no information on the site conditions in the lagoon and landfill which were monitored was included in the comment so the Agency is unable to determine whether these are typical disposal sites.

The Ferroalloys Association stated that emissions control dust behaves as a sealant when it attains a sufficiently high moisture content and therefore provides a barrier to migration of hazardous constituents.

No data were submitted to support this contention so the

Agency is unable to respond in detail to the comment. EPA solicits additional information on the overall effectiveness of emissions control dust/sludges as sealants, the amount of moisture required to make the wastes behave as sealants and the moisture content of landfilled dusts.

LISTING BACKGROUND DOCUMENT

GRAY AND DUCTILE IRON FOUNDRIES

Emission Control Dust from Gray and Ductile Iron Foundry Cupola Furnaces (T) (Proposed)*

I. SUMMARY OF BASIS FOR LISTING

Emission control dusts from gray and ductile iron foundry cupola furnaces are generated when the heavy metal contaminants found in the raw material scrap are entrained in the cupola furnace fumes as metal oxides and are subsequently collected

*The present proposed listing is limited to gray and ductile iron foundries collecting emission control dust from cupola furnaces. The Agency also has information indicating that gray iron foundries using electric arc furnaces generate an emission control dust with high concentrations of heavy metals, particularly lead. See U.S. EPA, Office of Air Quality Planning and Standards, Electric Arc Furnaces Foundries/Background Information for Proposed Standards, (Draft Environmental Impact Statement), EPA-450/3-80-020a (1980), pp. 726-27 (available from EPA Office of Solid Waste).) EPA thus may broaden the listing in the future to include electric arc furnaces. Further, in the sampling study described in the note below, EPA will sample some emission control dusts from electric arc furnaces to determine whether these wastes should be listed as hazardous.

NOTE: The Agency has made two prior proposals to list iron foundry process wastes. The first proposed listing, undertaken largely in response to comments received by the State of New York and Chem-Nuclear Systems, Inc., was of "lead/phenolic sandcasting waste from malleable iron foundries". This proposal was later altered (and the comment period extended) to cover "lead-bearing wastewater treatment sludges from gray iron foundries", 44 Fed. Reg. 674451, November 26, 1979). The present document expands the November, 1979 proposed listing to encompass a limited class of iron foundry emission control dusts.

These changes in the proposed listings have prompted industry complaints of having to respond to a moving target, making it difficult to comment responsively to the successive proposals.

The Administrator has determined that the emission control dust collected from gray iron and ductile iron foundry cupola furnaces is a solid waste which may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and, therefore, should be subject to appropriate management requirements under Subtitle C or RCRA. This conclusion is based on the following considerations:

1. Waste extracts from gray and ductile iron emission control dusts have been shown to release high concentrations of the heavy metals lead and cadmium. In all cases the concentration exceeded 100 times the drinking water standards for lead and cadmium, and in some cases exceeded 1000 times the standard.

2. Large quantities of these wastes are generated annually, increasing the quantity of lead and cadmium available for environmental release.

3. These wastes may be disposed of in wetland or discharge type areas, increasing the hazardous constituents' migratory potential.

The Agency is sensistive to these concerns. Moreover, the Agency presently is undertaking a sampling and analysis study of the gray iron foundry industry's emission control wastes. Data from the sampling study will be used to make a final determination of the regulatory status of emission control sludges (which wastes have already been proposed for hazardous waste identification), as well as the dusts proposed for listing in this document. The assistance of the foundry industry in undertaking this study is acknowledged and appreciated by the Agency.

The Agency, therefore, is not promulgating either listing (i.e. either emission control dusts or wastewater treatment sludges) in interim final form. Rather, both listings are proposals, and no final regulatory action will be undertaken until completion of the sampling study.

These wastes are of concern due to the presence of lead and cadmium in a form capable of migration in high concentrations.

II. SOURCES OF THE WASTE AND TYPICAL DISPOSAL PRACTICES

A. Profile of Gray and Ductile Iron Foundry Industry

Approximately 1166 gray iron foundries and 81 ductile iron foundries comprise these two industries (1). Although the foundries are located throughout the United States, a large portion of the plants are found in the Great Lakes area. Geographic distribution of gray iron and ductile iron foundries is shown in Table 1.

Gray iron is characterized by the presence of most of the contained carbon as flakes of free graphite in the as-cast iron. Gray iron is classified into ten classes based on the minimum tensile strength of a cast bar. The tensile strength is affected by the amount of free graphite present as well as the size, shape and distribution of the graphite flakes. Flake size, shape and distribution are strongly influenced by metallugical factors in the melting of the iron and its subsequent treatment while molten, and by solidification rates and cooling in the mold (1).

Ductile iron (also known as nodular iron, spherulitic iron, etc.) is similar to gray iron composition with respect to carbon, silicon and iron content, and in the type of melting equipment, handling temperatures, and general metallurgy. The important difference between ductile and gray iron is that the graphite in ductile iron separates as spheroids or nodules (instead of flakes as in gray iron) under the influence of a few hundredths of a percent of magnesium in the composition.

Table 1 (1)

Distribution of Total Gray and Ductile Iron Foundries

	Gray Iron	Ductile Iron
New England	77	3
Mid-Atlantic	188	9
Great Lakes	386	20
Plains	141	8
South Atlantic	101	7
East South Central	89	13
West South Central	80	9
Mountain	27	1
Pacific	77	11
	1166	81

The presence of minute quantities of sulfur, lead, titanium and aluminum can interfere with and prevent the noduling effect of magnesium. Although the molten iron for conversion to ductile iron must be purer than for gray iron manufacture, a small quantity of cerium added with the magnesium minimizes the effects of impurities that inhibit nodule formation and make it possible to produce ductile iron from the same raw materials used for high grade gray iron manufacture (1). Single foundries therefore are capable of producing both gray and ductile iron. Furthermore, since the same types of raw materials are used to produce each type of iron, waste composition also tends to be similar.

The general procedure for manufacturing ductile iron is similar to that of gray iron, but with more precise control of composition and pouring temperature. Prior to pouring of metal into the molds (and in some cases during pouring) the metal is innoculated with the correct percent of magnesium, usually in a carrier alloy, to promote the development of spheroids of graphite upon cooling (1).

B. Manufacturing Process (1)

1. Overall Process Description

While specific procedures vary from foundry to foundry, the overall operations for producing iron castings are essentially the same. These procedures include sand preparation, mold and core making, metal melting and pouring, casting shakeout and cleaning and finishing.

In all types of foundries, raw materials are assembled and stored in various material bins. From these bins, a furnace charge is selected by using various amounts of the desired materials. This material is charged into a melting furnace and made molten through a heating process.

Simultaneously, molds are prepared. This process begins by forming a pattern (usually of wood) to the approximate final shape of the product. This pattern is usually made in two pieces that will eventually match to form a single piece, although patterns may be 3 or more pieces. Each part of the pattern is used to form a cavity in a moist sand media, and the two portions of the mold (called "cope" and "drag") are matched together to form a complete cavity in the sand media. An entrance hole (called a "sprue") is cut to provide the proper paths of molten metal introduction into the cavity. The mold is then ready to receive the molten metal. In die casting operations the mold cavity is formed in metallic die blocks which are locked together to make a complete cavity.

The molten metal is then "tapped" from the furnace into the ladle. The ladle and molds are moved to a pouring area and the metal is poured into the molds. The molds are then moved to a cooling area where the molten metal solidifies into the shape of the pattern. When sufficiently cooled, the sand is removed by a process known as "shake out". By violent shaking, the sand surrounding the metal is loosened and falls to the floor or conveyor that returns it to the sand storage area.

The cast metal object (casting) is further processed by removing the excess metal, and cleaned by various methods that complete the removal of the sand from its surface. In the case of die casting, where no sand is used, the cast object is removed from the die casting machine after cooling sufficiently to retain its shape. The casting is either further cooled by a water bath or is allowed to cool by air on a runout or cooling table. Depending on the final use of the casting, further processing by heat treatment, quenching, machining, chemical treatment, electroplating, painting or coating may take place. After inspection, the casting is then ready for shipping.

2. Types of Furnaces used in Gray and Ductile Iron Production [1]

Three types of melting furnaces are used for the production of gray iron and ductile iron; cupola, electric arc, and electric induction furnaces. EPA estimates that 95% of the furnaces used for producing gray iron and ductile iron are cupola furnaces, and the present document covers emission control dusts only from this type of furnace. The differences among the types of melting furnaces are discussed below.

a) Cupola Furnaces

The cupola furnace is a vertical shaft furnace consisting of cylindrical steel shell lined with refractories and equipped with a wind box and tuyeres for the admission of air. A charging opening is provided at an upper level for

the introduction of melting stock and fuel. Near the bottom are holes and spouts from removal of molten metal and slag.

Air for combustion is forced into the cupola through tuyeres located above the slag well. The products of combustion, i.e., particles of coke, ash, metal, sulfur dioxide, carbon monoxide, carbon dioxide, etc. and smoke comprise the cupola emissions. Air pollution emission standards require that these emissions be controlled, and both dry and wet control systems are utilized for this purpose.

b) Electric Arc Furnaces

An electric arc furnace is essentially a refractory hearth in which material can be melted by heat from electric arcs. The molten metal has a large surface area in relation to its depth, permitting bulky charge material to be handled. Arc furnaces generally are not used for nonferrous metals as the high point of the arc tends to vaporize the lower melting temperature metals. Arc furnaces are operated in a batch fashion with tap-to-tap times of 1-1/2 to 2 hours. Power, in the range of 500-600 kwh/ton, is introduced through three carbon electrodes. These electrodes are consumed in the process of passing the electic current through the scrap and metal into the molten batch. They oxidize at a rate of 5 to 8 kg per metric ton of steel (10.5 to 17 lbs/ton).

The waste products from the process are smoke, slag, carbon monoxide and dioxide gases and oxides of iron emitted as submicron fumes. Dry collection air pollution control

equipment (usually baghouse) is generally used to control electric arc furnace emissions [1].

c) Induction Furnaces

Induction melting furnaces have been used for many years to produce nonferrous metals. Innovations in the power application area during the last 20 years have enabled them to compete with cupolas and arc furnaces in gray iron and steel production. This type of furnace has some very desirable features. There is little or no contamination of the metal bath, no electrodes are necessary, composition can be accurately controlled, good stirring is inherent and, while no combustion occurs, the temperature obtainable is theoretically unlimited.

There are two types of induction furnaces: (a) coreless, which is a simple crucible surrounded by a water-cooled copper coil carrying alternating current, and (b) core or channel, in which the molten metal is channeled through one leg of a transformer ore. The induction furnace provides good furnace atmosphere control, since no fuel in introduced into the crucible. As long as clean materials such as castings and clean metal scrap are used, no air pollution control equipment is necessary. If contaminated scrap is charged or magnesium is added to manufacture ductile iron, air pollution control devices are required to collect the fumes that are generated.

C. <u>Waste Generation and Management</u> (1)

The cupola furnaces in gray and ductile iron foundries require emission control systems. Both wet and dry systems are utilized. Venturi scrubbers are used exclusively for wet

crubbing of cupola furnace fumes and baghouses are used exclusively for dry collection of emissions. The waste collected by dry systems (baghouse dust) is the waste of concern in this document.

The use of a baghouse involves the collection of particulate matter by entrapment of the particles in the fabric of a filter cloth that is placed across a flowing gas stream. These dust particles are removed from the cloth by shaking or back-flushing the fabric with air. The resulting dry dust is usually collected in bins or open trucks (2). It is then often mixed with other foundry wastes prior to ultimate disposal in landfills.

It is estimated that for gray and ductile iron foundries, 10-22 lbs. of emission control dust is generated for every ton of metal produced (14). Approximately 95% or 1185 foundries use cupola melting furnaces. A known 392 foundries use wet collection systems and therefore EPA assumes that the remaining 793 (~65%) use dry dust collection systems. In 1979, 16,741,000 tons of metal were produced by the industry (3). If 65% of this amount is assumed to be produced by the 65% of the gray and ductile iron plants that generate a dry dust, then a range of 54,000 to 120,000 tons of dust will be generated by the industry per year. This estimate is probably low (2).

Foundry wastes are land disposed (1). Wastes from many foundries are monofilled, but others are disposed at municipal or private sanitary landfills which also accept other types of solid waste (2). Disposal procedures include random dumping

and grading, combination with other municipal and industrial wastes, and grading upon deposition followed by application of earth and topsoil cover (2). The physical setting of the disposal sites varies; locations are generally selected on the basis of availability of land at an appropriate cost within a reasonable haul distance from the foundry. It has been a fairly common practice to dispose of foundry wastes in wetland or discharge type areas where waste materials can become saturated with surface waters or shallow groundwaters (2).

D. Hazardous Properties of the Wastes

1. Waste Composition

The Agency believes that these emission control dusts ordinarily contain high concentrations of lead and cadmium, and that these toxic metals are capable of migration in quantities sufficient to create a substantial hazard if the wastes are managed improperly.*

The following data support this conclusion. Gray and ductile iron foundry cupola furnace emission control dusts from three foundries operated by the Mead Corporation were tested using the EPA extraction procedure, and in all cases the extract contained lead and cadmium significantly in excess of 100 times the National Interim Primary Drinking Water Standard. These data are presented in Table 2 below.

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* The raw materials used as charge account for the lead and cadmium present in the emission control dust. Automotive scrap is thought to be one principal source of heavy metal contaminants (14). If engine block is used as scrap charge, the source of lead may be paint, tetraethyl lead deposits or engine bearings. If auto bodies are used as scrap, the source of lead may be attributable to paint or, more likely, to solder used to fill in joints (15).

TABLE 2

FOUNDRY EP TOXICITY TEST SUMMARY [14]

	Level of EP Toxicity	Detection Limit	Green Sand Cupola Dust	Shell Mold Cupola Dust	Cupola Dust			
					Dry Dust	Dry Dust	Wet Dust	Dry Dust
Location			LB	LB	AC	RD	RD	LB
Date Sampled			5-8-79	5-8-79	8-22-79	10-30-78	10-30-78	10-78
Parameters								
Cadmium (mg/1)	1.0	0.01	6.9	4.8	2.5	19.6	6.6	12.9
Lead (mg/1)	5.0	0.05	16.5	12.8	11.5	96.0	68.0	2.3

LB = Lower Basin Foundry (Gray and Ductile Iron)
AC = Archer Creek Foundry (Gray and Ductile Iron)
RD = Radford Foundry (Ductile Iron)

Note: Analysis for other heavy metals and the 129 priority pollutants revealed no significant concentrations of any of these parameters.

The charge for these foundries is believed to consist primarily of fairly high grade (clean) metal scrap from a number of sources [14]. Facilities accepting lower grade scrap (such as automotive body scrap) could have higher concentrations of these metals in their emission control dusts.

These leachate extract results indicate strongly that improper management of the wastes could lead to migration of dangerous concentrations of cadmium and lead from the waste. A further concern in assessing potential hazards posed by these wastes is the possibility that existing disposal practices may not always be adequate, since disposal in wetlands and municipal landfills is said (in an industry publication) to occur. Since lead and cadmium appear to be present in these wastes in leachable form, waste disposal under conditions where leaching media are readily available could well lead to migration of contaminant-bearing leachate which can then migrate to ground or surface water. Disposal in acidic environments, such as landfills containing municipal refuse (another waste management practice known to occur (2)), could also lead to environmental release of dangerous concentrations of lead and cadmium. Improper disposal of these dusts can therefore result in contamination of ground and surface waters with lead and cadmium. Aquatic species might be affected, and where ground and surface waters are sources of drinking water, ingestion of the contaminants by humans could occur.

In addition an inhalation hazard may be posed by management of this waste due to its fine particulate nature and due to the inhalation toxicity of the particulates. The dust could easily become airborne and cause damage to humans if the waste is not properly buried at the time of disposal. The waste also could pose an inhalation hazard during transportation if it is transported in open trucks and no precautions are taken to prevent dust from blowing freely.

These wastes also are believed to be generated in substantial quantities (see page 10 above). This is further cause for concern, since large amounts of the toxic constituents cadmium and lead are thus available for potential environmental release. The large quantities of these contaminants pose the danger of polluting large areas of ground and surface waters. Contaminantion could also occur for long periods of time, since large amounts of pollutants are available for environmental loading. The attenuative capacity of the environment surrounding disposal facilities could also be reduced or exhausted by such large quantities of pollutants. All of these considerations increase the possibility of exposure to harmful constituents in the waste and further justify a hazardous designation.

2. <u>Hazardous Properties of Waste Constituents</u>

The cadmium and lead that may migrate from the waste to the environment as a result of improper disposal practices are heavy metals that persist in the environment and may contaminate drinking water sources for extremely long periods of time. Cadmium is toxic to practically all systems and

functions of the human organism (6). Acute poisoning may result from the inhalation of cadmium dusts and fumes (usually cadmium oxide) and from ingestion of cadmium salts (7). Lead is poisonous in all forms; it is one of the most hazardous of the toxic metals because it accumulates in many organisms and the deleterious effects are numerous and severs. Lead may enter the human system through inhalation, ingestion or skin contact. Ingestion of contaminated drinking water is a possible means of exposure to humans as a result of improper management of these wastes. Inhalation hazards are also possible through exposure to the airborne dust which contains lead oxide and cadmium oxide. Additional information on the adverse health effects of cadmium and lead can be found in Appendix A.

The hazards associated with exposure to cadmium and lead have been recognized by other regulatory programs. Lead and cadmium are listed as Priority Pollutants in accordance with §307(a) of the Clean Waster Act of 1970. Under §6 of the Occupational Safety and Health Act of 1970, a final standard for occupational exposure to lead has been established (8). Also, a national ambient air quality standard for lead has been announced by EPA pursuant to the Clean Air Act (8).

In addition, final or proposed regulations of the States of California, Maine, Massachusets, Minnesota, Misouri, New Mexico, Oklahoma and Oregon define cadmium and lead-containing compounds as hazardous wastes or components thereof (9).

EPA has proposed regulations that will limit the amount of cadmium in municipal sludge which can be landspread on crop land (10). The Occupational Safety and Health Administration (OSHA) has issued an advance notice of proposed rulemaking for cadmium air exposure based on a recommendation by the National Institute for Occupational Safety and Health (NIOSH) (11). EPA has prohibited ocean dumping of cadmium and cadmium compounds except as trace contaminants (12). EPA has also promulgated pretreatment standards for electroplaters which specifically limit discharges of cadmium to Public Owned Treatment Works (13).

References

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2. American Foundrymen's Society. Foundry Landfill Leachates from Solid Wastes, 1978.

3. The Metal Casting Industry Directory. Foundry Management and Technology Magazine, Penton Publications. July, 1977.

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5. U.S. EPA, RCRA Section 3001 Docket. Memorandum of phone call from Claire Welty to Mead Corporation.

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9. U.S. EPA, Office of Solid Waste, State Regulations File, January, 1980.

10. 44 FR 53449.

11. 44 FR 5434.

12. 38 FR 28610.

13. 40 CFR, Part 413.

14. U.S. EPA, RCRA Section 3001 Docket. Memorandum of meeting with Mead Corporation, June 25, 1980.

15. U.S. EPA, RCRA Section 3001 Docket. Memorandum of phone call from Russell Frye of Mead Corporaton to Claire Welty. July 8, 1980.

V. Response to Comments

A number of comments have been received which address the Agency's proposed listing of wastewater treatment sludges from gray iron foundries. As noted above, the Agency is undertaking (with industry assistance), a sampling study of selected foundry wastes and does not plan to proceed to finalize this listing or to abandon the listing until the study is completed. The Agency does feel that it is necessary to restate its justification for proposing to list these wastewater treatment sludges, both to respond to criticism that the proposal lacks justification and to indicate our concern that these wastes could pose a very real hazard if disposed of improperly.

First, these waste sludges could contain large quantities of lead, a toxic element. EPA analyzed raw and treated wastewater samples from five plants. These data and resultant lead levels found in the sludge at these five plants are summarized as follows (1):

Plant	Lead Concentration in Raw Wastewater (mg/l)	Lead Concentration in treated Wastewater (mg/l)	Lead Concentration removed from wastewater(mg/l)	Flow (gal/ day)	Total Lead (pound year)
A	40	2.2	37.8	4.8×10^4	3,80
B	54	0.9	53.07	3.86×10^5	42,70
C	29	1.4	27.6	4.24×10^5	24,40
D	100	8.5	91.5	1.13×10^6	216,00
E	140	0.87	139.13	7.49×10^4	21,70

Note: This type of mass balance approach provides an accurate indication of amounts of lead in the wastewater treatment sludge, since lead neither degrades nor volatilizes.

Thus, total potential environmental loadings of lead from these wastes appear to be high. Further, over 5 million wet tons of these wastes are generated annually on a national basis (1), increasing concern about total potential lead loadings.

Second, lead will be present in these wastes in higher concentrations than concentration of lead removed from the waste water, since the sludge will be dewatered, and the lead therefore concentrated, before disposal.

Third, an industry publication indicates that "(i)t has been a fairly common practice in disposal of foundry solid wastes ... to use wetland or discharge type areas. In areas such as these, waste material is often water-saturated from the presence of surface water or shallow groundwater". ("Foundry Landfill Leachages from Solid Wastes", American Foundrymen's Society, 1978.) Under these conditions, dangerous concentrations of lead could leach into ground and surface waters and reach environmental receptors.

o Industry has indicated that although lead is present in these sludges, it is present in a substantially immobile form. One of the purposes of the sampling study is assess the potential mobility of waste constituents. Although this is not the sole determinant of a waste's toxicity (see §261.11), it is certainly a significant factor in making a ting determination. Thus, the results of waste extract 'rom the upcoming sampling study will be taken into ·tion in making a final listing determination.